Costs and Benefits of Superfast Broadband in the UK

Paolo Dini, Claire Milne and Robert Milne

Department of Media and Communications

London School of Economics and Political Science

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EXECUTIVE SUMMARY

This paper was commissioned from LSE Enterprise by Convergys Smart Revenue Solutions to stimulate an open and constructive debate among the main stakeholders about the balance between the costs, the revenues, and the societal benefits of 'superfast' broadband. The intent has been to analyse the available facts and to propose wider perspectives on economic and social interactions.

The paper has two parts: one concentrates on superfast broadband deployment and the associated economic and social implications (for the UK and its service providers), and the other considers alternative social science approaches to these implications. Both parts consider the potential contribution of smart solutions to superfast broadband provision and use. Whereas Part I takes the "national perspective" and the "service provider perspective", which deal with the implications of superfast broadband for the UK and for service providers, Part II views matters in other ways, particularly by looking at how to realise values beyond the market economy, such as those inherent in neighbourliness, trust and democracy.

Part I: Prospects for superfast broadband in the UK

Great expectations

Superfast broadband is too new for there to be much evidence of its effects on the market economy and society as a whole. The paper therefore summarises expectations for its effects, based on such evidence as there is from basic and fast broadband. In particular, there appear to be causal connections between broadband deployment and the growth of the market economy, although the direction of causation is not always clear (let alone the size of any effect). Expectations about this growth, and new applications enabled by broadband, lie behind much of the enthusiasm for superfast broadband among governments. However, to make effective use of broadband there remains a need (which is sometimes overlooked) for basic training in e-skills for everyone at work and at home.

Applications of broadband include several that foster the development of society, by encouraging participation, both in civic affairs and in communities of many sorts (Wikipedia contributors, open source software development teams, special interest groups, and so on). The rewards for participating in such 'virtual communities' are not usually monetary; they include feelings of "belonging", being esteemed, and being satisfied with jobs well done. Participation is usually beneficial and has sometimes, as in open source software development, high value to other participants in the market economy. The Internet helps the development of transactions involving such non-monetary rewards, just as it helps the development of commerce.

The Internet can, of course, have both good and bad effects: perhaps the most troublesome bad effect is the 'digital divide' that separates ever more active users of the Internet from non-users. The paper outlines the bad effects in general and the digital divide in particular. Low Internet take-up among older age groups limits

the rate at which society can be said to be "fully wired": no matter how widespread high-speed coverage may be, approaching 100% take-up is likely to take another 15 years.

Overall the assessment confirms that currently planned investments in superfast broadband are a sound way ahead for the next few years. Widespread provision at lower speeds should be given preference over partial provision at higher speeds, and problems which result from difficulties in adapting to rapid change are not likely to be solved by even more and faster change.

Making the investments

There has been a stream of announcements about providing, extending or bringing forward fibre coverage; the paper aims to clarify these and establish what funding is available. To do this it outlines the different broadband technologies currently used in the UK, the government and regulatory policies to support the spread of broadband, and the published plans of the main infrastructure providers for fibre deployment.

Much fibre deployment is likely to precede the contribution of 4G wireless technologies to extending broadband reach, partly because of delays to the 4G spectrum auction. However, there are some possible contributions of wireless technologies that are not so affected by these delays, such as the use of licence-exempt and "white space" spectrum for final connections with fibre backhaul.

Estimates of broadband deployment costs are available for both fibre and wireless technologies. When they are modified so that mixtures of technologies can be compared, they show how, on reasonable assumptions about take-up and use, the lowest-cost technology varies with the extent of coverage. Inevitably, costs of provision (per premises connected) are higher for lower population densities, where wireless technologies become increasingly appropriate even for fixed network access.

The Government's Universal Service Commitment for basic broadband to reach the whole country by 2015 is on course. Moreover, even without the use of the current government funding, fast broadband might have 90% coverage in 2013 (unless other programmes are allowed to take precedence) and superfast broadband should have 66% coverage in 2014. These developments are building on previous achievements, in a virtuous circle of growing supply and demand. However, attaining the government targets of 100% fast broadband coverage and 90% superfast broadband coverage in 2015 will require not only the government funding and matching funding from the local authorities and devolved administrations, but funding from private sources. In fact the funding from private sources might need to be roughly as much as that from public sources. However, this estimate is approximate: funding requirements could vary very considerably, depending on the characteristics of local areas, the costs of activities other than deployment, and take-up.

Universal availability and widespread use of high-speed broadband services will be fundamental to the future international competitiveness of the UK, as well as to social cohesion. Although the costs of broadband infrastructure run into billions, they are modest compared with the costs of energy and transport infrastructure, which together are forecast to absorb over £200 billion of investment. They are also modest compared with the benefits and savings from them. Yet the funding from all public sources for broadband up

to 2015 is likely to be smaller than, for example, the government revenue from the forthcoming digital dividend spectrum auction (which is expected to be between £1.1 billion and £2.5 billion).

Finding the revenues

The paper compares the costs of being a superfast broadband service provider with those of being a fast broadband provider, by considering the published wholesale prices (several of which are intended to be cost-oriented). Currently in the UK the difference in costs is smaller than the difference in retail prices of superfast broadband and fast broadband, but both prices (and the difference between them) could well fall, to the detriment of profit margins.

Accordingly, the paper turns to the available evidence about the returns on investment available to service providers. Early adopters have been prepared to pay a small premium for superfast broadband. However, though they have changed how much they use some existing applications, they have not as yet found any compelling new applications. Mass take-up might depend on large-scale adoption of Internet video for entertainment, with innovative pricing plans that would appeal to potential new users, such as special offers for off-peak entertainment.

Innovative pricing plans are among the service features that would let service providers boost demand and manage network capacity by using smart solutions. The service features described in the paper are intended to cut costs, attract new users and stimulate new uses in ways beyond, but not far beyond, what is done currently. They can encourage consumers to take up Internet use, make best use of the available network resources, share their communications and computing capacity, and treat service providers as trusted intermediaries for micropayments. They typically entail introducing incentives for use while taking account of how people are known to behave; for instance, tangible incentives must be designed very carefully to avoid "crowding out" intangible motivations, such as enhancing reputation. They also take account of the relations between innovation, non-discrimination and charging for Internet use, which particularly in the US have produced the debate about 'net neutrality'; the paper suggests principles for combining effective stimuli to producing and using applications, efficient use of network capacity, and appropriate returns on investment in an 'open network'.

The paper also provides two examples of how service providers can exploit smart solutions to help their business customers. One deals with machine-to-machine communications, particularly for smart power grids; the other deals with generalising from micropayments to broader financial operations. In both cases smart solutions are made available to customers who need the billing capabilities that such systems provide. It is not possible to quantify the effects of smart solutions, but the cost savings and revenue increases that they facilitate should jointly make a significant contribution to covering the private sector investment in reaching the government targets.

Part II: Alternative approaches to valuing investment in broadband

The second part of the paper analyses the problem of generating a return for superfast broadband investment by examining the concept of "value" from different points of view. It focuses on community currencies

(CCs) as an illustration of alternative ways of expressing value, and places them within a conceptual model derived from economic anthropology.

In outlying areas of the UK the business case for superfast broadband is difficult, so a long-term objective is to develop a framework through which untapped social value in these areas can be connected to the revenue flows of the online service market. The research question is whether CCs and smart solutions, acting together, could potentially provide this framework. This question is approached in two ways, through examining CCs and through introducing economic anthropology as a means of looking at economic value, and followed by a more applied view of possible integration.

CCs are interesting because they can be seen as "laboratories of institutional learning" and sources of ideas for how the social and economic dimensions of society might be better integrated. Their successful implementation and management depend on a complex integration of social, economic, and governance processes that are far from trivial even when taken individually. The successful example of the Swiss WIR shows how such integration may be achieved. Economic anthropology provides a model that can explain phenomena like CCs, and the consequences of extending the conception of "economy" beyond the market. Therefore, it can provide some reassurance that integrating CCs in the economy may strengthen socio-economic growth.

Finally, the paper explores the relevance of CCs to a digital economy with superfast broadband and smart solutions. It gives an example of an outdoor museum in which visitors using smart phones can access explanatory and background material provided by volunteers, who are remunerated with a CC that is tied to the local economy. Such a system is potentially relevant to superfast broadband and smart solutions, depending on the content and services offered, but it is unlikely to scale up beyond a very limited geographical area. By contrast, a business-to-business virtual community utilising a CC like WIR is more likely to have a noticeable impact on the size of the online economy. Online games provide another example of how an electronic currency, community dynamics, business transactions, a sizable overall turnover, superfast broadband, and various online services relevant to distributed gaming environments can come together in a very innovative way that has significant socio-economic relevance.

Thus the problem of increasing the return from investment in superfast broadband in outlying areas of the UK can be addressed by direct intervention by service providers aimed at improving the economic conditions in those areas. Experience with the WIR suggests that service providers could gain from this approach by introducing similar participatory "non-profit" banking systems tailored to the digital economy and based on community currencies. In such a scenario smart solutions would play an essential role in mediating the complex cash flows of, and between, multiple currencies.

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1. INTRODUCTION

Superfast broadband is now being deployed in the UK.[1] There have already been many papers on its costs and benefits in the UK and in the rest of the world. However, there are various reasons why another one is justified:

- There are continuing government announcements about funding for broadband deployment and industry announcements of new deployment initiatives.
- The emphasis of much work tends (naturally) to be on costs, and on benefits that are relatively easy to quantify.
- There is a risk that we will lose sight of the ability of broadband to contribute to society in other ways besides those that we know how to quantify.

This paper was commissioned from LSE Enterprise by Convergys Smart Revenue Solutions with the objective of stimulating an open and constructive debate among the main stakeholders about the balance between the costs, the business case, and the societal benefits of superfast broadband. Our intent has been to analyse the available facts and some of the available data and to propose a wider perspective on economic and social interactions. As it is mainly secondary research this paper includes many references, ranging from press releases to large volumes.[2] In this paper we:

- Describe the expected overall effects of superfast broadband, both for the market economy and for society as a whole (in Chapter 2).
- Summarise the relevant technologies, government policies, regulatory activities and implementation programmes that affect service providers (in Chapter 3).
- Identify the costs and returns to service providers, as far as is realistic (in Chapter 4).
- Consider some network-based applications that could help to achieve the overall social and economic objectives implied by the investment in superfast broadband (in Chapter 5).
- Summarise and critique the main properties of community currencies as an 'out-of-equilibrium' economic phenomenon important for stimulating the economy at the periphery (in Chapter 6).
- Discuss how the overall benefits of broadband to society can be seen as an integral part of a definition of the economy that goes beyond the market (in Chapter 7).
- Suggest business models based on this wider conception of the economy and the possibility that community currencies could be part of a quantifiable financial backbone for it (in Chapter 8).

In this chapter we provide some background to these later chapters and indicate how they fit together.

[1] Throughout this paper we follow Ofcom by taking 'superfast broadband' to have downlink speeds greater than 24 Mb/s. We also take 'basic broadband' to have downlink speeds less than 2 Mb/s and 'fast broadband' to have downlink speeds between 2 Mb/s and 24 Mb/s.

[2] We are grateful to Neil Rathbone of DaventryHouse.com for providing the Q-Archive example.

1.1 The National Perspective

From a national perspective, superfast broadband can be seen as another step towards the full electronic connectivity of individuals and organisations. It goes beyond earlier steps, of basic broadband leading to fast broadband, but its effects are intimately bound up with the effects of those earlier steps. Because it is new, so far there is little evidence of effects specific to it and no evidence yet of long-term or large-scale effects.

For basic and fast broadband the effects are better documented, having been studied from various perspectives.[3] These involve varied terminology and concepts; for instance, the terms 'ICT adoption', 'information society', 'knowledge economy', 'ubiquitous network', 'digital dividend' and 'media literacy' all bring different but related ideas into people's minds.[4] In this paper we do not explore these relationships; deeper explorations can lead in many different directions.

We do, however, summarise in Chapter 2 expectations about the effects of superfast broadband, based on evidence from basic and fast broadband. This evidence is smaller than might be envisaged, but it does exist. In particular there appear to be causal connections between broadband deployment and the growth of the market economy, although the direction of causation is not always clear. Expectations about this growth and the introduction of new applications form the background for much of the enthusiasm for superfast broadband among governments.

Among these new applications are some that lead to the development of society, by encouraging participation, both in civic affairs and in communities of many sorts (open source development teams, special interest groups, amenity societies, and so on), which might be called 'virtual neighbourhoods'. The rewards for contributing to such communities are not usually monetary; they include feelings of "belonging", being esteemed, and being satisfied with jobs well done. The Internet helps the development of transactions involving such non-monetary values, just as it helps the development of commerce. We look at this in Chapter 2, especially by examining when the Internet can be an 'open network', and return to it in Chapter 5.

As well as good effects, the Internet can, of course, have bad effects, which we also discuss in Chapter 2; perhaps the most significant of them is the deepening of the 'digital divide' that separates ever more active users of the Internet from non-users. Often the bad effects are mitigated by countervailing good effects; this might be so, for example, for the carbon emissions resulting from more data transfers and large server farms, which might be offset by the effects of less travel to work and meetings.

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[3] Broadband Commission for Digital Development (2011) lists over 100 published studies which are relevant to the economic effects of broadband; of these between 20 and 30 date from 2009 or later, and are wholly or mainly about advanced economies. As it says (http://www.broadbandcommission.org/about.html), the Broadband Commission for Digital Development, set up by UNESCO and ITU, aims to demonstrate that broadband networks "have the same level of importance as roads and electricity networks; ... are basic infrastructure in a modern society; are uniquely powerful tools for achieving the Millennium Development Goals...; are remarkably cost-effective and offer an impressive return-on-investment...; underpin all industrial sectors and increasingly are the foundation of public services and social progress; must be coordinated nationally by governments in partnership with industry...".

[4] The OECD has an extensive series of Digital Economy reports at http://www.oecd-ilibrary.org/science-and-technology/oecd-digital-economy-papers_20716826?page=1, many of which are relevant to the topic of this paper.

The national perspective includes not just aspirations but also actions. In particular, to support superfast broadband deployment the government has made funding available to local authorities and devolved administrations, and the regulator, Ofcom, has made changes that require the introduction of certain wholesale fixed network services; Ofcom will also, in the fullness of time, auction spectrum for mobile network services. Correspondingly large service providers, spurred partly by these initiatives and partly by competition, have developed implementation plans and started to deploy superfast broadband. In doing so, some, at least, will wholesale facilities to others on an 'open access' basis. All these actions we summarise in Chapter 3.

Though service providers bear much of the costs , their returns are only part of the benefits to society; this is why governments provide public funding. Where there are benefits to other sectors of the market economy, such as health care, there might need to be new institutional arrangements to promote, for example, trans-sectoral co-operation and community involvement. There are yet further benefits that might be seen in social relationships, for example, more than in monetary transactions; sometimes the economic consequences of these benefits can be estimated, but often they are not estimated or are not taken into account, so the economic justification for deployment must stand without them. A conception of 'value' that is broader than that provided by the market economy can help to bring these benefits into focus.

1.2 The Service Provider Perspective

The national perspective is concerned with the effects of superfast broadband on the market economy and society as a whole. Service providers have, besides this perspective, a perspective of their own: they are naturally concerned with the costs and returns to them. Unless they have satisfactory business cases there will be no superfast broadband. These business cases depend on the government funding, regulatory changes and implementation plans summarised in Chapter 3.

Implementation costs, which determine much about implementation plans, have been estimated in various ways in the past. In Chapter 4 we apply to the most widely considered of these estimates shared assumptions about take-up, so that mixtures of implementation technologies can be compared more easily. Doing this lets us examine the extent to which the government funding, regulatory changes and current implementation plans will be enough to fulfil the government aspirations for superfast broadband.

We also look at such evidence as there is about the returns on investment available to service providers. However, we do not provide a business case. It would depend on too many questionable assumptions about the returns. Though we can make some general statements about likely characteristics of new applications that might generate substantial returns, the overall effect can depend on fashions and other aspects of human behaviour that are not easily predicted.

Nonetheless, service providers can use several tactics to obtain adequate returns on investment, as we identify in Chapter 4. For instance, there are many millions of people in the UK who do not use the Internet;

service providers could attract them with innovative pricing plans that give them access to the entertainment and information that superfast broadband can deliver. Also, service providers could, with suitable pricing and other tools, make effective use of their investments in superfast broadband to meet customer expectations without wasting network capacity.

We expand on this theme in Chapter 5, where we discuss examples of service features that can attract new users and stimulate new uses. These are intended to be beyond, but not far beyond, what is done currently; in some circumstances incremental steps are the most successful, even for disruptive technologies. Specifically the service features provide ways in which people can be encouraged to take up Internet use, make best use of the available network resources, share their communications and computing capacity, and treat service providers as trusted intermediaries. In doing so they draw attention to various relevant aspects of human behaviour, such as the demotivating effects of some monetary incentives and the habit of putting money into separate mental accounts, that have been explored in behavioural economics.

In Chapter 5 we also consider two examples of how service providers can exploit advanced support systems to produce new markets. One of these examples concerns machine-to-machine communications, particularly for smart power grids. The other concerns virtual applications of the support systems themselves, either for virtual service providers or for customers who need the billing capabilities that such systems provide.

1.3 A View from Far Out

In policy discussions it is common to speak of three groups of stakeholders: government, business and citizens.[5] The opinions held within each group of stakeholders, about broadband investments as well as everything else, are far from homogeneous. In particular, while there is a common understanding of the costs to some extent, the understanding of the benefits varies, because parts of the benefits are not generally 'commodified' (in other words, quantified in monetary terms according to their market value). A sufficiently granular classification of the stakeholder viewpoints for our purposes distinguishes between monetary value and non-monetary value, or, in other words, between the economy of the market, and the economy outside the market. Thus 'the economy' becomes based on a broad definition of value that goes beyond quantified and commodified market exchanges.[6] In Chapter 7 we pick up the thread started in Chapters 2 and 5 so that the overall benefits of broadband to society can be seen as part of this wider conception of the economy. In Chapter 8 we develop the implications further, with business models based on this wider conception of the

[5] Lumping together large companies like BT with small software start-ups is motivated by recognising that businesses share essential traits regardless of their size, and these traits are fundamentally different from the traits of the government and of the citizen.

[6] This view of the economy is associated with the field of economic anthropology, e.g. Gudeman (2001), and its origins are generally ascribed to Polanyi (1944). See also New Economics Foundation (2010).

economy, within which community currencies,[7] which are introduced in Chapter 6, might be used in quantifiable exchanges.

Figure 1.1 shows a possible schematic or 'value map' of this wider conception of the economy. The concepts and items shown in the figure are only examples, and their placement is to some extent a subjective preference. For example, there is not really a market for buying and selling parts of countries (except in a few historical cases such as the sale of the Louisiana Territory to the United States by France), but Gross Domestic Product (GDP) can be regarded as the total of a country's market economy, or in any case an approximation thereof. Tax is also related to the market economy, although indirectly. Both concepts relate to a specific understanding of value that is expressible in units of currency.

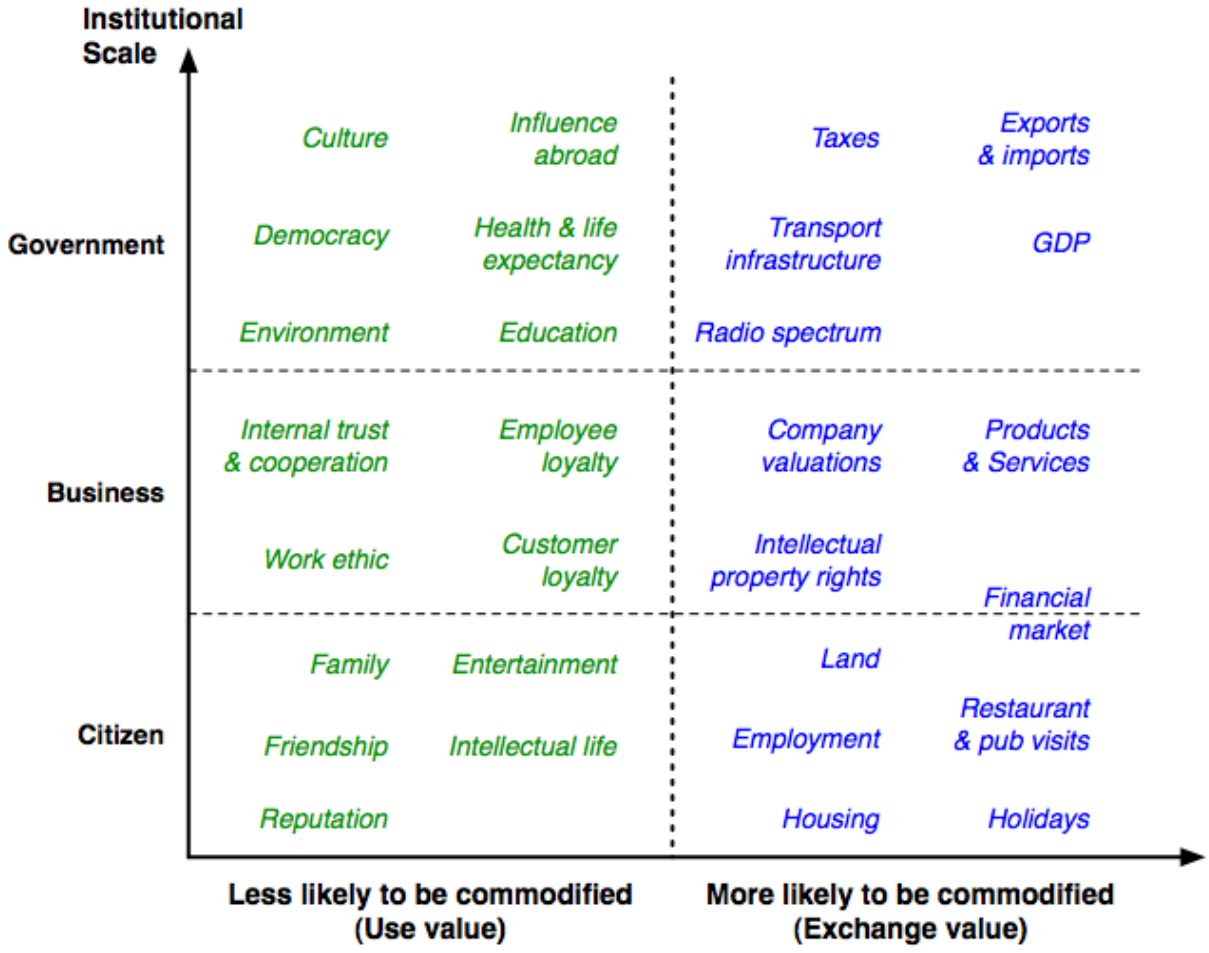

Figure 1.1: A possible map of stakeholder concerns and types of socio-economic value

[7] Community currencies are similar to and sometimes can be interchanged with 'alternative currencies', 'parallel currencies', 'complementary currencies', and 'local currencies'. The use we make of this concept in this paper is limited to examples where the term 'community currency' will serve well. However, we also use the term 'virtual currency' in certain contexts, as that is the more usual term among online communities, such as participants in games and virtual worlds.

In the left column of the diagram are shown concepts whose value is not easily expressed in terms of currency, although for some of them their cost can be approximated in this way. The point here, for example about education, is that the value to a nation of its educational system is hard to measure but vastly greater each year than its education budget. In the business layer the interpretation of the concepts on the market side is straightforward. On the left are all the 'soft' concepts that are responsible for how a company is perceived by its employees and/or by its customers. Only a part of this kind of value is translatable into a monetary value for company valuation.[8] A similar description applies to the lowest, individual layer in the figure. In general, the distinction between the left column and the right column is one of degree: social relationships can affect monetary transactions when, for example, an open source programmer trades on her reputation to obtain employment or promotion.[9]

The two columns in the figure can also be understood in terms of the use value/exchange value dichotomy. Although the concepts of use value and exchange value were first proposed by Aristotle, Adam Smith came up with this telling explanation: 'Some things, like water, have high use value but low exchange value, whereas other things, such as diamonds, have low use value but high exchange value' (Smith, 1776, cited in Gudeman, 2001: 15). A less extreme juxtaposition is explained by Jackson:

> *Use value* describes the value of a thing which only has value when used. That value is realised in the process of consumption. On the other hand, goods which are not consumed in the direct course of human reproduction can be exchanged for other goods which might, in turn, have a direct use value. Such goods have an *exchange value*: they become a *commodity*. In this way exchange values are described as being relations between use values. (Jackson, 1997; citing Marx in Harvey (1973)) [Emphasis in original] [10]

These definitions suggest that the use value and exchange value labels shown in Figure 1.1 should be seen more as probabilities than mutually exclusive categories.

[8] There are companies that have created a huge human capital, but that are not necessarily valued highly on the market. For example, since its founding in 1938 HP was regarded as having a very good company culture, 'the HP Way' (Burrows, 2004), in the sense of Kaplan and Norton's balanced scorecard (1991), but its current valuation is more dependent on how the hi-tech sector is doing, how the printer market is doing, and so forth (see for example Dolan (2011)).

[9] Though this is intuitively obvious, evidence for it other than anecdotes is limited. However, it is confirmed by an econometric study (Hann et al., 2004), which shows that participants in the Apache open source web server development project get salaries in their "real" jobs that are between 14% and 29% higher if they have higher ranks in the Apache organisation (though this does not happen if they just contribute more program fragments). The reputations of the participants could be said to have monetary value, insofar as they are represented in differences in ranks that correspond with differences in salaries.

[10] In spite of these references, our theoretical perspective is not Marxist or Marxian. Our approach is opportunistic as regards social science theories and concepts. We try to use terminology that seems effective at expressing the ideas we want to communicate. The concepts of use value and exchange value, for example, reflect some of the differences between community currencies and national currencies, which will be discussed in Chapters 6 and 8.

The distinctions between the principal interests and value systems of the stakeholders in Figure 1.1 are reflected in the social sciences, which provide different approaches to identifying and defining value for different stakeholders. For example:

- The interest of a government tends to be articulated in a macroeconomic analysis of value in the market economy. However, other matters can come to the fore, particularly in special situations, such as (in the UK) the looting in 2011, wars or elections.
- The interest of a business is better characterised by a microeconomic analysis aiming to maximise individual company utility.
- The interest of a citizen may be characterised by noting that an individual value system is influenced strongly both by society and culture (as in subjectivist sociological theories) and by cost and usefulness (as in functionalist/objectivist theories). From a different angle, behavioural economic studies add to our understanding of how people make decisions.

Even with these different perspectives, the landscape of the value map is more complicated than Figure 1.1 depicts. First, other kinds of value exist beyond use value and exchange value. Family, religions, friendships, romantic relationships and so forth have many other kinds of value. In this paper we are interested more specifically in *economic* value, which we could define as being concerned ultimately with the sustenance of the individual and of society.[11] Where the boundaries of such a value system should be drawn is the issue at stake. Rather than relying solely on the well-established economic theory of public, private, excludable, and rivalrous goods, we cast the net wider to the field of economic anthropology, which sees economic systems as resulting ultimately from cultural processes. In the rest of the paper we move between the prevailing understanding of the economy and the economic anthropology view, but in all cases the meaning should be clear from the context.

1.4 The Perception of the Wider Economy

Most economists see markets as emergent from voluntary exchange. This reflects to a large extent the empirical record, but does not exclude other forms of economic exchange. In addition, it does not imply that in a state of nature 'man' will have a 'propensity to barter, truck and exchange one thing for another',[12] to the exclusion of other forms of behaviour or motivation. Already in 1944 Polanyi characterised this view as 'out of date', and boldly developed the point as follows:

> But the same bias which made Adam Smith's generation view primeval man as bent on barter and truck induced their successors to disavow all interest in early man, as he was now known *not* to have indulged in those laudable passions. The tradition of the classical economists, who attempted to base the law of the market on the alleged propensities of man in the state of nature, was replaced by an abandonment of all interest in the culture of

[11] The first line in the Wikipedia definition of 'Value (economics)' is, 'An economic value is the worth of a good or service as determined by the market' (http://en.wikipedia.org/wiki/Economic_value) .
[12] In the words of Adam Smith (2007[1776]: 9)

> the "uncivilized" man as irrelevant to an understanding of the problems of our age. Such an attitude of subjectivism in regard to earlier civilizations should make no appeal to the scientific mind. … For if one conclusion stands out more clearly than another from the recent study of early societies, it is the changelessness of man as a social being. His natural endowments reappear with a remarkable constancy in societies of all times and places; and the necessary preconditions of the survival of human society appear to be immutably the same. The outstanding discovery of recent historical and anthropological research is that man's economy, as a rule, is submerged in his social relationships. He does not act so as to safeguard his individual interest in the possession of material goods; he acts so as to safeguard his social standing, his social claims, his social assets. He values material goods only insofar as they serve this end. (Polanyi, 1944: 47) [Emphasis in original]

The case here is starkly overstated, but it serves to clarify the point.[13] Polanyi integrates also concerns for physical sustenance with this perspective, but as it would take us too far afield to explain this in any detail we refer the reader to the original source, and note that in the information society the above points are increasingly borne out by Web 2.0 phenomena. If we take the most extreme interpretation of 'free market' as one whose establishment only requires transactional contracts, it is easy to rebut that, in fact, market activity requires a basis of reliable credit and payment mechanisms, regulatory and conflict-resolution institutions, robust infrastructural and logistical support, and so forth. In other words, a healthy economy requires a fair amount of structure beyond the market mechanisms that implement transactional contracts. Whereas the financial system and the technological infrastructure are relatively easy to recognise, a host of societal structures and institutions become harder to see the more they depend on who we are and how we behave, because we tend to take them for granted and to forget the role that they play in the wider economy. For this reason they require a more careful analysis and discussion.

For example, we tend to take for granted a minimum level of accountability in our elected politicians, and tend to forget that in many other countries such accountability is still part of a utopian dream, far into the future. But the impact of the concept of accountability on business and on the economy in general is palpable in the UK, and it is a very positive impact. It is not at the centre of daily discussions because it is so much a part of the culture that it is both invisible and obvious. And yet, it is the basis of trust, whose effects on society at large, well beyond market transactions, are deep and far-reaching. The perception of the UK economy and society, therefore, is paradoxical:[14] on the one hand the UK has some of the strongest democratic institutions in the world and a distinguished cultural tradition, which permeate all three institutional layers of description; on the other hand, the effects on the economy of such non-commodifiable elements of the social fabric (some of which appear on the left of Figure 1.1) are not generally accounted for beyond the vague notion of 'societal values' or the acknowledgement of their indirect influence on quality of life.[15] But the neoclassical perspective cannot be summarily dismissed:

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[13] A recent Economic Focus column in *The Economist* cites the report of Kuziemko et al. (2011), whose behavioural economic study of people near the bottom of the income distribution suggests that they care more that they should not be overtaken by those beneath them than that they themselves should rise.

[14] See Mansell (2012) for an in-depth discussion of paradox in information society and knowledge economy debates.

[15] See also an interesting article in the *Irish Times* that further elaborates on this concept (Molloy, 2011) as it applies to Ireland during the current economic crisis.

> Political Economy or Economics is a study of mankind in the ordinary business of life; it examines that part of individual and social action which is most closely connected with the attainment and with the use of the material requisites of wellbeing. Thus it is on the one side a study of wealth; and on the other, and more important side, a part of the study of man. (Marshall, 1920[1890]: I.I.1)

More specifically, in the neoclassical view a society of utility-maximising rational agents will implicitly maximise also their social welfare. Thus, although the causal link is here very much up for debate, we will still need to tread carefully. In any case, even giving neoclassical economics its due, Part II of this paper will explore the ramifications of moving beyond it; for example, in Marshall's definition of wealth, of removing the limitation whereby 'it excludes [man's] personal friendships, in so far as they have no direct business value' (Marshall, 1920[1890]: II.II.11).

1.5 The Emphasis for the Information Society

Enlarging the discussion beyond traditional understandings of the monetary value of products and services to be traded on the market is especially important for the information society. As examples of its relevance:

- As is evident from the growing trend in illegal downloads of content and as discussed in some detail by the Hargreaves report (2011), the Intellectual Property Rights (IPR) landscape is changing, in the UK and in the rest of the world. As Benkler (2006) explains, the emergence and growth of immaterial goods and digital content is challenging established notions of private property and the increase in available bandwidth is amplifying the problem. The government is taking these trends seriously, but the current inability to connect value generated outside the market to business cases and, more generally, to the country's GDP creates a constraint for policy that is very difficult to ignore.
- The pervasiveness of open source software and, especially, the integration of its development with market-based business models has established that also in the West the non-market part of the economy is not just an academic abstraction. Speaking about the marketing power of "free" goods, Chris Anderson remarks, 'The "Linux ecosystem" is a $30 billion industry … we have essentially created an economy as big as a good-sized country around the price of $0.00' (Anderson, 2009: 3).

Therefore, the challenge in a discussion of the costs and benefits of superfast broadband is to develop a framework through which different kinds of value to different stakeholders can not only be *recognised* but also *related*. This is challenging because such "exchange rate mechanisms" between different kinds of value are still far from being fully understood, let alone formalised and implemented. A possible example of how this might be done will be discussed in more detail in Chapter 8.

This paper aims to develop a conceptual framework that can aid the assessment of the costs and benefits of the superfast broadband rollout based on a fuller accounting of both that is compatible with market understandings but that, at the same time, goes beyond strictly monetary investment and return on investment. This paper thereby aims to make a small contribution towards a concept of the digital economy that is suitable for the 21st Century.

PART I. CURRENT PLANS AND PROSPECTS FOR SUPERFAST BROADBAND

Claire Milne and Robert Milne

2. EXPECTED EFFECTS OF SUPERFAST BROADBAND

According to an interview with Robert Madelin, Director-General, Information Society and Media, European Commission (EC),

> Fast and ultra-fast Internet access will play a central role in economic recovery and in providing a platform to support innovation throughout the economy, as electricity and transport did in the past. The roll-out of ultra-fast networks will stimulate a virtuous cycle in the development of the digital economy, allowing new bandwidth-hungry services to take off and creating incentives for the further development of eHealth, eLearning, smart grids and media content in the future. (Ducatel, 2010)

These remarks summarise current public statements about the reasons for the push towards broadband. For such reasons, governments in advanced economies worldwide are keen to see superfast broadband spread in their countries, and fibre is being laid in most countries around the world. The UK is no exception. This chapter provides a brief overview of the main arguments in support of this position, while at the same time highlighting uncertainties and alternative viewpoints. In doing so it also draws attention to the need to maximise not only the number of people who have broadband (whether basic, fast or superfast) available to them but also the number of people who take advantage of that availability.

2.1 The Growth of the Market Economy

To continue with the remarks of Robert Madelin,

> Moreover, according to the OECD, cost saving of 0.5% to 1.5% in four key sectors of the economy (i.e. electricity, health, transportation and education) over ten years can result directly from building a new ultra-fast broadband platform. (Ducatel, 2010)

Strictly speaking, the relevant OECD report (OECD, 2009) does not say this; it says, rather, that these cost savings would need to result from building the platform if they were to justify building it.[16] Because the expenditure on these sectors is high, such savings might be attainable, even for Fibre To The Premises (FTTP) networks such as those modelled by the OECD.[17] Whether these savings need superfast broadband, as opposed to basic broadband, is a different matter; the proposed application of broadband in the energy sector, for example, is smart metering, for which the speed and delay requirements can be met easily by current wireless technologies (Ofgem, 2010). Nonetheless the possible cost savings in certain sectors

[16] The cost saving required in the UK would be 0.84% under the assumptions adopted in Section 4.1.

[17] The OECD, and many other organisations, actually discuss Fibre To The Home (FTTH). We refer to FTTH as "FTTP", because "FTTP" is more widespread than "FTTH" in the documents that we cite. However, some authors use "FTTP" to mean Fibre To The Building (FTTB).

motivate the trans-sectoral approach, advocated in Budde (2009), for example, according to which budget allocations and institutional arrangements for government departments bring about investment in shared infrastructure that no one sector could pay for on its own.

The OECD models what the savings must be if they are to justify the costs. A popular alternative way of assessing high-level economic impact is to estimate the percentage increase in GDP caused by a given increase in broadband take-up. It is relatively easy to show that the increases are correlated, but much harder to establish causation. A thesis (Czernich, 2011), applying the best available statistical techniques to data from twenty OECD countries during the years 1996-2007, suggests that increasing broadband penetration by 10 percentage points increased annual per capita GDP growth by between 0.9 and 1.5 percentage points.[18] Other studies, such as Booz (2009), Qiang et al. (2009) and McKinsey (2011), have reached similar conclusions. However, sometimes the grounds for the conclusions are not entirely secure; for instance, they might identify broadband diffusion with ICT diffusion in general. Moreover, in general the techniques capture initial introduction effects and do not provide projections into the future.

If, focusing on one direction of causation, increasing broadband take-up can cause economic growth, how does it do so? One possible answer is that broadband spurs innovation. Some evidence from nine OECD countries can be interpreted as implying that, during the introduction of broadband (between 1998 and 2002), increasing broadband penetration by 1 percentage point increased innovations by between 3.5 and 5.3 percentage points (Czernich, 2011). This might be explained by noting that broadband helps communities of interest to grow, through email, websites and so on, without being collocated.[19] In doing so it is achieving 'virtual agglomeration'. This is the internet equivalent of the process by which people or organisations that work on similar or related matters in the same location attract others to work there: they create opportunities for employees, suppliers, subcontractors, distributors and even competitors.[20]

Jobs greatly affect life satisfaction as well as incomes, and broadband investment is expected to generate jobs. For instance, looking specifically at the UK, a paper (Liebenau et al., 2009) estimates that investing in ICT infrastructure would result in significant job creation, concentrated in small enterprises. Specifically, it suggests that £15 billion of investment split equally among broadband networks, intelligent transport systems and smart power grids would generate or retain around 700,000 jobs for one year, more than half of which

[18] The statistical techniques entail first modelling the growth in the extent of broadband use (in other words, how many people use it) and then correlating this growth with the growth in GDP after controlling for several possible influences. However, they do not model the intensity of broadband use (in orher words, how, and how much, people use it) and make no distinction between basic broadband and fast or superfast broadband.

[19] It might possibly be explained instead by suggesting that broadband reduces the effort needed to find suitable goods or services and thereby stimulates competition, which in turn spurs innovation. However, the evidence that reductions in search and other transaction costs (through online shopping) stimulate competition is not very conclusive: for some categories of goods, though prices have fallen the falls do not correlate well with broadband take-up, and variations in prices for the same goods from different suppliers have not reduced (Van Reenen et al., 2010).

[20] Nonetheless so far ICT design enterprises have tended to cluster in particular locations, often near universities. Also, despite the wealth of teaching material available online, universities themselves have not yet become "virtual" in significant numbers.

would be in small enterprises. At 280,500 jobs, broadband has the highest effect on jobs of the three investment areas.[21]

Creating new jobs is not enough without reshaping the workforce to fill those jobs. Proposals have been put forward to create the optimal mix of skills for the Knowledge Economy in the UK (e-skills UK et al., 2009). A major report on how the EU can improve its economic performance using ICT (Van Reenen et al., 2010) also highlights the importance of labour reform.

2.2 The Development of Society

The effects on economic growth (or, at least, the requirements for international competitiveness) are not alone in generating excitement about broadband; the benefits associated with large-scale applications have done so, too.[22] For instance, we hear much about e-government, e-commerce, e-health, and e-education (and smart buildings and smart grids, although differently named, could join the list). However, it is hard to pin down the benefits from broadband, let alone any extra benefits from superfast broadband.

We take as an example e-health. This is a relatively promising field for worthwhile returns from superfast broadband, because (for example) remote interaction between doctors and patients can be much more effective if it incorporates high definition real time moving images. A study in Australia (Access Economics, 2010) bemoans the paucity of legitimate conclusions about the cost-effectiveness of e-health in large numbers of studies. Using an assessment method developed for the US and scaling up figures from small trials, it then estimates direct health care savings to be between AU$300 million and AU$750 million per year from remote consultation and monitoring, without accounting for the cost of broadband. It also suggests that higher benefits, between AU$2 billion and AU$4 billion per year could be attributed to broadband if broader social benefits (for example, to employers) were taken into account. Analogous figures do not appear to be available for the UK.[23]

More generally, we comment that:

- The effect of broadband on personal internet use has been well documented. Because it can be "always on" without extra payment, and because it has greater speed and convenience than dial-up, people with broadband use their internet connections more often, for longer and for a wider variety of purposes than was the case with dial-up (OECD, 2007). These effects are typically rather large

[21] However, a statistical investigation of the rural areas of Germany (Czernich, 2010) failed to find a relation between broadband availability and unemployment. This does not necessarily imply that broadband availability has no effect on the labour market, because online job searches are believed to affect how frequently employed people change jobs even if they do not affect how easily unemployed people find jobs.

[22] Several of our references provide good starting points for exploration of such fields; in particular, Broadband Commission for Digital Development (2011) is wide-ranging and up-to-date.

[23] Remote monitoring with mobile phones is believed to have benefits, but financial constraints on the National Health Service restrict investment in new systems, even using existing communications technologies (Hall, 2011).

(for example, there can be a jump of 10 to 30 percentage points in the proportion of users who engage in a particular online activity). Thus certainly the shift from dial-up to broadband has led to a shift in the extent and nature of online activity.

- Much online activity replaces activity that would have taken place offline if it could not have taken place online. For instance, online tax returns replace paper equivalents, and online shopping may replace mail order or physical shopping. As such, the benefits of online applications often come in the form of saving costs (often transaction costs) rather than in the form of better, or new, products or services. However, they rarely permit the withdrawal of the offline alternatives.[24]
- Achieving the benefits is rarely simple, as it often requires widespread managerial and behavioural change by service providers as well as take-up by users. Large organisations (like government departments) may have particular difficulty in introducing the necessary changes, especially when they are obliged to do so in exemplary ways[25]. Consequently, supposed benefits may take longer than expected to materialise. This is particularly true of services like education and health care where close personal contact is often valued highly.
- Benefits accrue most easily to early adopters. People who might benefit most from new applications in their own homes (for example, the elderly or disabled) are likely to be later adopters and to need the most support to realise the benefits. So even where there is an overall social benefit, it may come at the cost of (at least temporarily) increasing inequality.

It remains intuitively appealing that such applications of broadband are, or will eventually become, worthwhile. Still, caution is needed when predicting the benefits from services that require both large investments to provide and significant changes to use.[26] We look now at some online activities that instead develop partly from the citizens up, rather than from the government down.

Even before the advent of broadband, and of applications with user-generated content, users of the Internet were developing communities of interest. They now do so in ever-increasing numbers, and report that such communities make them feel "as if they belonged". The experiences offered by these communities will continue to expand; for instance, high quality bidirectional video can let community meetings have virtual face-to-face contact. The value of broadband in developing social relationships (frequently termed 'social capital') can be substantial.[27]

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[24] 22% of income tax returns in the UK were filed offline in 2011, eleven years after online filing started. This was a decrease of 7% since 2010, but the rate of decrease was thought to be falling.

[25] For example, they are obliged to ensure high security for personal data (sometimes at the expense of easy access), and to adopt best practices for accessibility to people with disabilities. The long drawn out travails of the National Health Service to digitise medical records and share the records appropriately are a sad example.

[26] OECD (2008) discusses measurements for analysing the effects of ICT on society and the economy (and the effects of society and the economy on ICT).

[27] In a study of Luxembourg (Pénard et al., 2010) the majority of internet users reported that they used the internet to improve their social capital. Also, statistical analysis showed that people were more likely to use the internet to maintain social relationships if they had many such relationships and were more likely to use the internet to create social relationships if they were skilled with ICT or had time on their hands. However, the analysis did not provide evidence for various other plausible hypotheses about social relationships and the internet.

The Internet also helps to enhance participation in community affairs. It lets people express, and organise support for, opinions in new ways, such as those due to mySociety (http://www.mysociety.org) or 38 degrees (http://38degrees.org.uk). Evidence from the UK election of 2005 shows that the internet can increase participation in elections, but only for people with little interest in politics (Anderson et al., 2007).[28] Viewing this differently, people who do not use the Internet are likely to become ever more disenfranchised, as well as to have no access to the most efficient ways of using government services and choosing large purchases.

By making available more ways of doing things, for contingency plans and after unexpected events, superfast broadband should allow greater resilience to shocks in the economy and society. For instance, if there were an epidemic or a massive transport disruption, even people who normally travel to offices could work at home (Plum, 2008). Doing this might then lead them to change their normal practice and take up full-time the video collaboration and communication tools for meeting colleagues that superfast broadband would more effectively enable.[29]

2.3 The Differences Made by Superfast Broadband

As with any long-term investment, benefits are harder than costs to pin down: benefits are reaped over many years, and are more uncertain the further into the future we look. Identifying the difference made by superfast broadband, as opposed to basic or fast broadband, is harder still. Here we mention a few relevant studies and offer our own conclusions.

A study (Plum, 2008) outlines a framework for assessing the value of superfast broadband beyond that offered by fast broadband. In doing so, it provides estimates of some, but not all, costs and benefits as indicative examples, but does not aggregate the estimates in a business case. It concludes that, waiting for eighteen months, or in some circumstances five to ten years, before making major public commitments (and using this period to prepare for efficient deployment) could well be the wisest course. Of course the eighteen months is now over, and the public commitments discussed in Section 3.2 have been made.

The study also stresses the importance of various longer-term wider economic and social benefits. These are typically "externalities", in that the benefits are not confined to the providers and users of broadband. They are difficult to quantify for many reasons; for instance, they may be apparent in social relationships more obviously than in monetary transactions, or they may depend on changes of human behaviour that are difficult to predict well. Several of them are discussed elsewhere in this paper (particularly in Sections 2.1 and 2.2, but also in Chapters 6 and 7 as part of a wider discussion that in essence seeks to internalise the

[28] In rural areas of Germany, also, participation in elections has been shown to be higher where broadband is conveniently available (Czernich, 2011).

[29] In 2010 3.7 million people in the UK (12.9% of the workforce) worked mainly from home (TUC, 2011). Some people are put off working from home by feeling a need to be seen at work, particularly in a recession. Others are put off by the limited social experience that working from home often offers and that better broadband provision could alleviate.

externalities). Others, which display clearly the need to offset the good effects of broadband with the bad effects when evaluating the benefits, are:

- **Net reductions in traffic congestion**. These must take into account the need to install ducts and poles, as well as the growth in working at home and in attending meetings remotely. Yet even working at home could make matters worse: it might increase car journeys to schools and shops while decreasing those to offices, and it might increase power consumption in houses without decreasing that in offices.
- **Net reductions in greenhouse gas emission**. These must take into account the expenditure of energy during network deployment and operation and the intensive computing and communication needed by new applications. For instance, the balance between distributed and centralised computing is unclear: a personal computer at home might be inefficient but it will not in the UK require the air conditioning needed in a server farm.[30]

A later study (Ingenious Consulting Network, 2010), which examines the relative benefits from expanding fast broadband coverage and upgrading basic broadband connections, concludes that there is a strong case for governments (in various OECD countries) to subsidise the deployment of basic or fast broadband to households not reached by the market.[31] However, the case becomes progressively weaker as the provision of higher speeds to all households is considered. Fundamental to this conclusion is the view that most new activities made possible by broadband are already possible with basic or fast broadband: higher speeds mainly allow the same things to happen faster or with higher quality, while the extra costs of providing higher speeds to everyone are very significant.

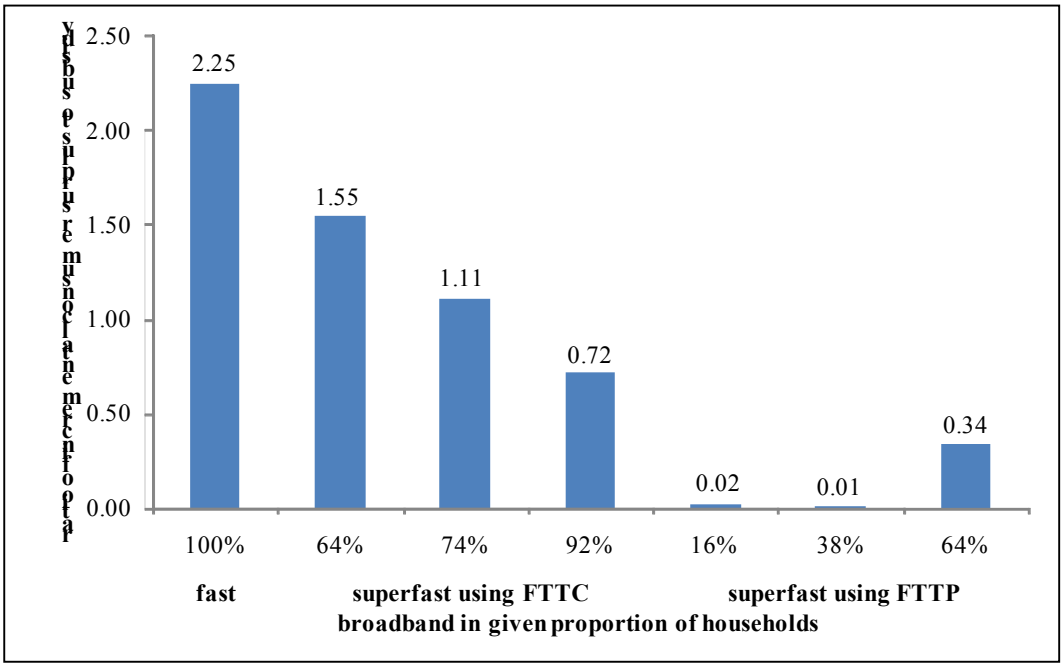
Figure 2.1 summarises this argument visually; according to it, subsidising the deployment of fast broadband to reach 100% of households in the UK would generate £2.25 of consumer surplus for every £1 of subsidy while subsidising the deployment of superfast broadband to reach 92% of households would generate only £0.72 of consumer surplus for every £1 of subsidy.[32] Putting this differently, to justify deployment, for every £1 of subsidy, superfast broadband would need to generate at least £0.28 of externalities on top of those provided by fast broadband.

[30] Server farms might replace inefficient single processors but they can themselves consume vast amounts of electricity: Google prefers to site them where cheap hydroelectric energy is available, and has one that is said to need as much power as a town of 200,000 people (ITU, 2008).

[31] That paper depends on essentially the same cost data as used in this paper (and by Ofcom). However, its "standard broadband" is our "basic or fast broadband", its "fast broadband" is our "superfast broadband using FTTC" and its "superfast broadband" is our "superfast broadband using FTTP". Its differences in consumer surpluses might therefore relate more to differences in deployment and operating costs than to differences in service capabilities.

[32] This assumes that, without subsidy, by 2015 97% of households will be able to get fast broadband and 38% of household will be able to get superfast broadband using FTTC (but more recent projections are higher for superfast broadband using FTTC). It also estimates the costs of providing fast broadband to the remaining 3% as the costs of using FTTC.

A further paper (Kenny et al., 2011) reinforces the argument that questions subsidising the deployment of superfast broadband; it emphasises that several widely cited justifications for investment in basic broadband do not obviously apply to fast or superfast broadband.[33] However, the argument is challenged in an article from the BSG (Walker et al., 2011). It points out that time savings are evaluated in cost-benefit analyses for large transport projects but not usually for superfast broadband. It grants that such an evaluation would be difficult to do, but comments that a time saving of only 1% of the aggregate time spent online today, valued at leisure rates, could generate about £300 million benefit per year. This is in line with an earlier calculation for the BSG (Plum, 2008).



Source: Ingenious Consulting Network (2010) with our adjustments to terminology

Figure 2.1: Relative effectiveness of subsidies for various options for broadband deployment in the UK

The value of the time saved by doing existing Internet activities faster is contentious: whether people would make effective use of short time savings is questionable, if they already multi-task or use the time for stress management.[34] However, a similar £300 million benefit would result if high-definition video conferencing could save £100 for 1% of UK flights; given the large number of business flights, and the high cost of work time, this saving seems plausible.

Intelligent transport systems might result in greater savings. A reduction of 1% in travel time for business journeys on UK roads would generate a benefit of £500 million per year (Eddington, 2006). However, intelligent transport systems would first require substantial public investment in infrastructure and private

[33]An interesting point from the paper is a reference to an estimate of 9 Mb/s as the "bandwidth of the human eye", that is, the rate at which the optic nerve transmits data to the brain for processing

[34] In a trial by BT in 2004 of one form of Fibre To The Premises only one in four of the residential users noticed a change in downlink speed from 2 Mb/s to 10 Mb/s.

investment in vehicles, and, as in the case of smart metering mentioned in Section 2.1, their need for superfast broadband is not clear. Communications between vehicles and roadside beacons can use relatively low speeds; higher speeds, or multicasting and multiplexing, are needed further into the network when many vehicles communicate with control centres at almost the same time. However, the control centres themselves might want access to superfast broadband interfaces to perform cloud computations that would detect trends and devise alternative routes (though a preconfigured list of these would cover many eventualities).

Of course, time savings should be taken into account in a full conventional cost-benefit analysis, along with other benefits that are even harder to quantify. Also, though public investment in higher speeds might offer diminishing returns, it does so in a non-linear way: the costs of communication technologies differ greatly, as outlined in Section 4.1, and unexpected new applications could greatly affect demand. Nonetheless, the argument that widespread provision at lower speeds should be given preference over partial provision at higher speeds seems well made: as discussed in Section 2.5, the UK is far from deriving all the benefits available from basic broadband. Also, where superfast broadband brings benefits above those from basic or fast broadband, it is likely to intensify the disadvantages. In particular, problems which result from difficulties in adapting to rapid change are not likely to be solved by even more and faster change.

2.4 Avoiding the Bad Effects

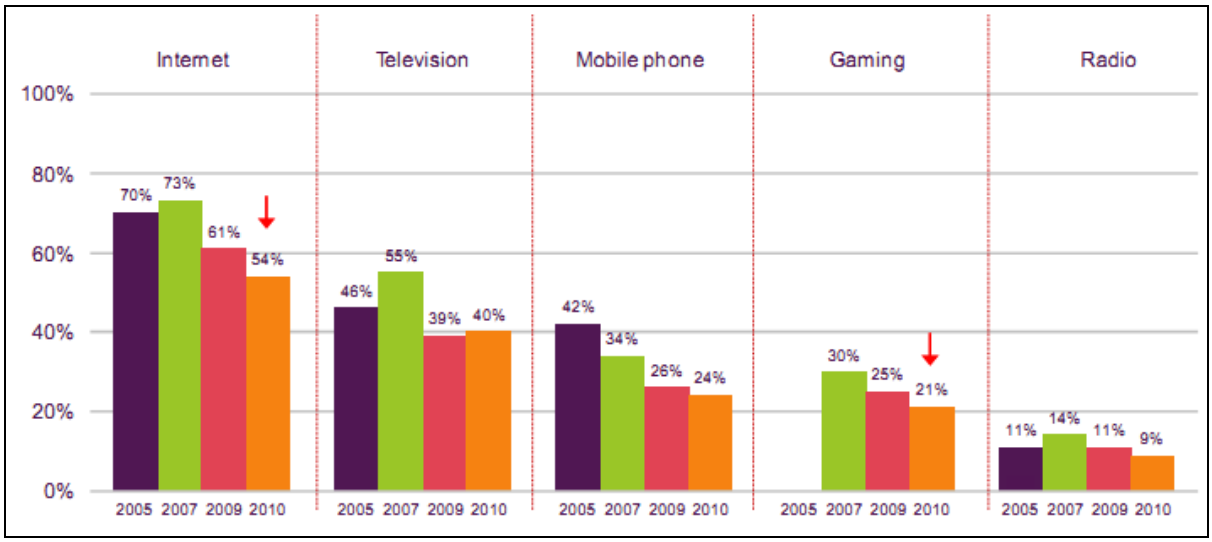
Apart from its evident costs, does broadband have actual disadvantages? Certainly, a glance at the press would suggest that it does. Concerns include:

- The rights and wrongs of peer-to-peer file sharing, and attempts to control copying of digital material.
- Safeguarding of personal information, including the commercial use of data on web use and purchases.
- Child safety online, with particular reference to pornography, exposure to strangers of dubious identity, and bullying.
- The flood of spam, overwhelming genuine attempts to communicate.
- The debasement of human relationships through computer-mediated communication.[35]
- The potential for the web to support nefarious activity, by making relevant information available (for example, on how to make a bomb) and helping malicious groups to organise themselves.
- Health risks attributable to sitting during both work and leisure, when the download of a film eliminates even the activity of walking to the front door to collect a DVD from the post.
- Excessive time spent online, leading to neglect of other types of activity and social relationships, with risks of addiction, especially to online games and gambling.[36]

[35] An extreme case is that when people can post anonymously to web logs they can lose their inhibitions and indulge in rhetorical outbursts of hatred and violence against the web log owners or others (Postmes, 2001).

- The 'digital divide' between those who do and those who do not benefit from the Internet.

Some of these concerns are reflected in user surveys such as those by Ofcom. As shown in Figure 2.2, these surveys appear to show a decline in user concerns in recent years, possibly associated with growing use leading to greater skills and confidence. However, concerns among Internet users still outweigh those among users of other platforms; they include worries about offensive or illegal content, security, fraud, personal privacy and advertising.



Source: Ofcom (2011a), Figure 55.
Note: Arrows mark changes since 2009 that are significant at the 95% level.

Figure 2.2: Concerns among users of various communications platforms

Another serious concern is that economic change leads to job losses (the other side of the coin of cost savings) as well as job creation. Finding people to fill the new jobs may involve considerable retraining, even if relocation is not needed because the new jobs can be done from anywhere. Information Societies are good for people who are appropriately oriented, skilled and flexible; but it is unclear that the work opportunities offered by a full Information Society will match the talents, abilities and preferences of any given population. Indeed:

> There is a major upskilling need across all sectors to help the workforce keep pace with and fully utilise the proliferation of technology – from airport baggage handlers to postal workers to retail supply chain staff….In addition, there is a significant need for increased volumes of lower level skills development as workers who do not currently use digital technology at work need to do so….There is a need for accelerated investment in IT

[36] South Korea is especially notorious for this, with press articles on youths who do not eat or sleep for days on end, parents who starve real babies but feed virtual ones, and work camps for addicts. In 2009, 2 million people (4% of the population) were believed to be Internet addicted. As South Korea has emphasised broadband development for many years, and is now promoting superfast broadband vigorously, it might be thought especially relevant to the social effects specific to superfast broadband.

> user skills, particularly for older workers, lower skilled workers and unemployed people.[37] (e-skills UK et al., 2009)

This investment in useful skills (known as 'human capital') could pay off in leisure pursuits, as well as work. Overall, it could be very important to life satisfaction.

All of these concerns have some foundation, but they can be overstressed, and most can be addressed, while still maintaining the undoubted benefits of broadband. Of course, for these concerns, just as for the benefits, while there may be a clear association between the Internet and a social phenomenon, the strength and direction of any causal link are not always clear.

For example, child welfare online has been a particular focus of attention. Major studies throughout Europe have highlighted the opportunities and benefits to children online, as well as the risks (Livingstone et al., 2011). More use brings both more risk and more potential benefit, and improves digital literacy and safety skills. The policy implications are to do with managing risks, particularly through raising parents' awareness and training children in digital and safety skills, and promoting age-appropriate positive content. As for causal links, child abuse has always existed; the Internet may have broadened opportunities for some kinds of abuse, and has certainly made them more visible.

Similar messages of balance and common sense come through research surveys (Mieczakowski et al., 2011a) that BT commissioned to examine current concerns about how computer-mediated communication is affecting individuals and society. The research was accompanied by interviews with experts who have carried out investigations in several relevant disciplines (Mieczakowski et al., 2011b). A common theme of their remarks is that both individuals and society need time to adapt to changes such as the rapid spread of new forms of communication. The research surveys themselves, in four countries (Australia, China, the UK and the US), concluded that among their respondents:

- A minority used communications technology for more than six hours a day on average.
- Communications technology sometimes interfered with family time, when adults let work enter the home or children preferred the company of electronic devices.
- People sometimes felt distracted or overwhelmed by communications, to the detriment of their well-being.
- By consciously recognising and moderating use, families could feel in more control, increase their well-being and benefit from communications technology (by, for example, playing games together).

[37] The report is not explicit about the size of this challenge. Elsewhere, however, the same body has estimated a need for 40 million IT skills "development units" (where one unit is a rise of one skill level in one subskills group) for the 21 million people in the workforce who are not in a specialised occupational category. This compares with an estimate of about 4.4 million development units needed by the 1.5 million IT and telecom professionals, and a little more than this by an additional million professionals in the content and creative industries. The "technology-capable business people", in an intermediate occupational category, number around 4 million and also need extra skills.

- People often felt that communications technology made them feel better connected with friends and relatives.

Consistently with this, a study in Germany (Bauernschuster et al., 2011) found no evidence that broadband decreased social activity in general and found some evidence that it increased social activity by children.[38]

2.5 Spreading the Benefits

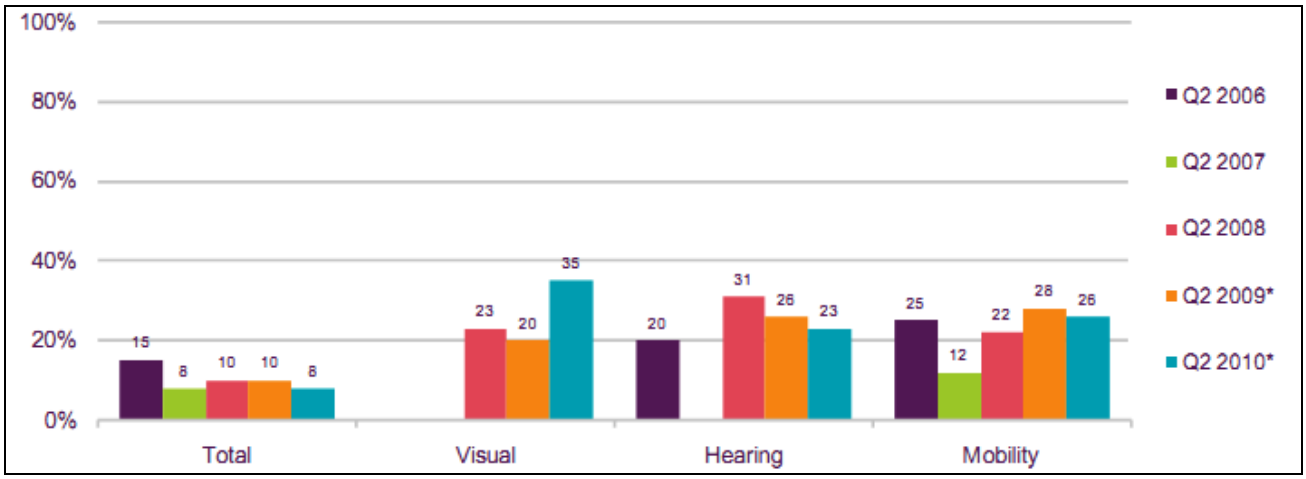
There remain up to 8.7 million adults in the UK who have never used the Internet (ONS, 2011b). There have been several analyses (for example, FreshMinds (2008) and Dutton et al. (2011)) of why this is so. Non-users now largely know about the Internet (though this was not so in earlier years). They can be grouped into the 'voluntarily excluded' and 'involuntarily excluded' as follows:

- **Voluntary exclusion.** People who are voluntarily excluded from Internet access typically say they see no need or place for the Internet in their lives. They belong predominantly to older age groups, have completed their education and work, have acquired most of the durable goods that they want, and are comfortable with their habits. They would resent being forced online, for example by the withdrawal of offline alternatives to services that they use. However, they might be motivated to go online by understanding the benefits for their own interests, such as hobbies or family contacts.
- **Involuntary exclusion.** People who are involuntarily excluded from Internet access encounter barriers such as:
    - **Cost.** In recent years this has reduced in significance, but it remains an important factor for younger people who are unconnected (Ofcom, 2009).
    - **Lack of skills or confidence**. There are widespread worries about handling terminal equipment or engaging with the Internet (with concerns such as viruses, spam, identity theft and unacceptable content).
    - **Disability**. Sensory, motor or intellectual impairments can all present major barriers to accessing or using the Internet. At the same time, Internet access can be of special benefit in preventing an impairment from resulting in disability.

More fully, Figure 2.3 illustrates how involuntary Internet non-ownership varies by disability (and compared with the total population sampled).[39]

[38] Germany is a good place for comparing the effects of having broadband with the effects of not having it. Before the introduction of Asymmetric Digital Subscriber Line (ADSL), parts of the east of the country were modernised by providing early Passive Optical Network (PON) connections. As they are formed from fibre, these PON connections are not suitable for ADSL, and, as they use telephony narrowband time division multiplexing, they are not suitable for Fibre To The Premises (FTTP) as conventionally understood. Thus the rest of the country has had better much broadband Non-users now largely know about the Internet (though this was not so in earlier years).

[39] Small sample sizes for the disabilities stop the figures for different years from being strictly comparable. Numbers above the bars indicate measured percentages.



Source: Ofcom (2010b), Figure 205.

Figure 2.3: Involuntary non-ownership of Internet by disability

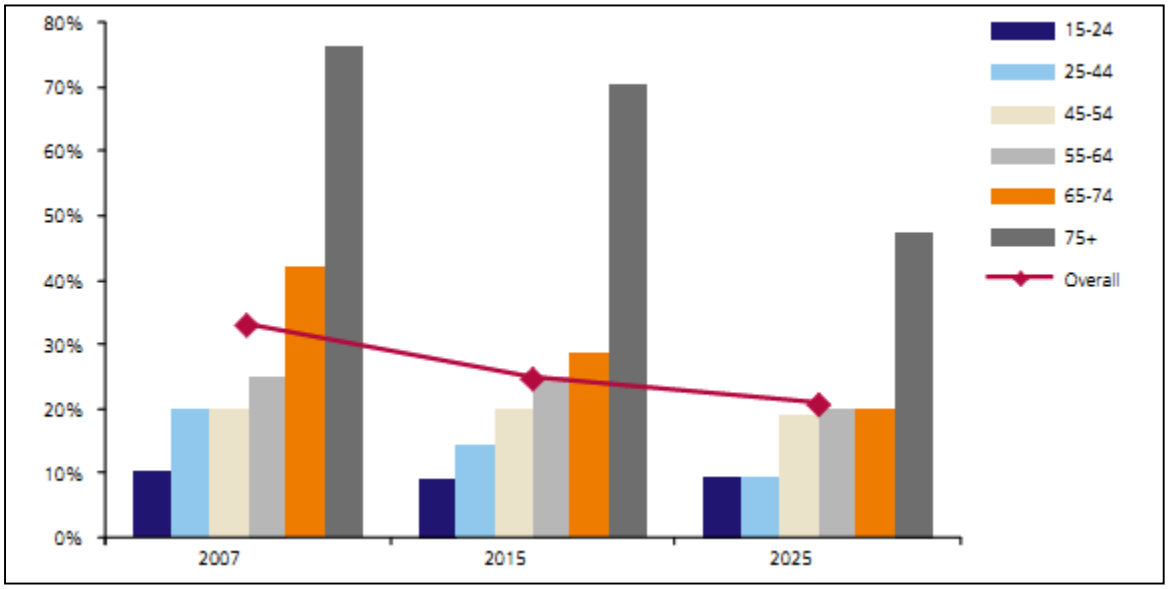
Table 2.1 shows how Internet access varies by broad age group and disability. While the samples do not permit adjustment for income or education, both of which are correlated with disability, it is fairly clear that there is a significant 'disability effect' which reduces rates of Internet connection and use.

Table 2.1: Home Internet take-up and use by broad age group and disability

Age	Home Internet take-up and use	
	Among people with a disability	Among people without a disability
16-64	71%	83%
65+	26%	47%

Source: Ofcom (2011c) with a special analysis for the Consumer Forum for Communications.
Total sample: 3474 UK adults; 602 with a disability; 2872 without a disability. (Disability self-identified as limiting daily activities or work).

Figure 2.4 reproduces projections to 2025 made in 2008 of the number of people in different age groups who were likely to remain offline. These could not have taken account of the success of more recent initiatives (BIS, 2010). However, they do show the reduction in over-75s offline to be expected through natural cohort effects, as well as continuing market-based growth. The percentage remaining offline in 2025 was expected to be 21%, strongly concentrated in older age groups. However, in this analysis significant percentages of people of working age were still expected to be offline in 2025, and presumably therefore at serious disadvantage in employment markets.



Source: FreshMinds (2008).

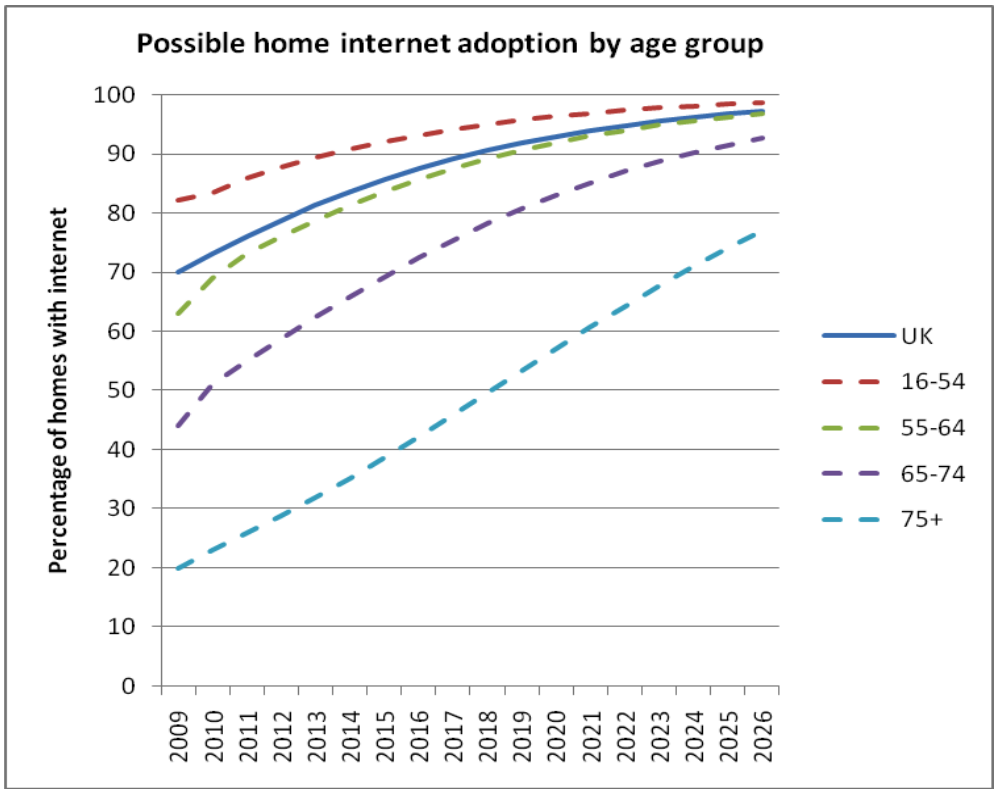
Figure 2.4: Projections for non-users of the Internet to 2025

A simple set of home Internet take-up projections carried out for this study is shown, for comparison, in Figure 2.5, showing the percentages of people in the given age groups who could possibly have Internet access at home in future. It is based on Ofcom's data for the whole of the UK annually since 2001, and for the different age groups for 2009, 2010 and 2011. The projections continue the trend that has taken place in the whole country since 2001,[40] and also apply it to each age group separately.

This provides a more optimistic picture than the FreshMinds study discussed above, mainly because it is based on recent achievement, which has been particularly encouraging. As it uses simple projections rather than detailed modelling of the factors affecting different age groups, it may well be over-optimistic, especially for the two older age groups. [41] Like the FreshMinds study, however, it makes it clear that 100% home Internet take-up has to be seen as a longer term goal. The near-term goal of getting everyone of working age online by 2015 might be achievable, on the assumption that "online" includes accessing the Internet from places other than their homes.

[40] Fitted by a simple curve in which percentage growth each year is a fixed proportion of the difference between the existing take-up and its ceiling of 100%. The fixed proportion derived from the historic trend is 0.15. Values from 0.1 to 0.2 are plausible but make little difference in the discussion above.

[41] The 2011 Oxford Internet Survey (Dutton et al., 2011) highlights that the number of older users is not growing fast, although (and in part, perhaps because) two thirds of non-users have the option of "proxy use", in which someone else can use the Internet for them.



Source: Study projections based on Ofcom (2011b) data for 2009-2011.

Figure 2.5: Age group differences and overall home Internet take-up

The characteristics of people still offline in 2011 include the following (ONS, 2011b):

- **Advancing age**. 76% of people aged 75+ have never used the Internet, and this group constitutes 40% of those who have never used the Internet. But in the age group 65-74, only 42% have never used the Internet (accounting for 26% of non-users). Consequently only 34% of all adult non-users are of working age (16-64); this group is targeted to be 100% online by the end of this Parliament.[42]
- **Disability**. 37% of people saying they were disabled had never used the Internet, compared with 12% of those saying they were not disabled. Thus disabled people account for nearly half of those who have never used the Internet. Of course, as the incidence of disability increases with age, there is a large overlap between this group and the preceding one.
- **Limited educational attainment and income**. Non-users disproportionately have lower educational levels and lower income than users, and are more likely to be in socio-economic groups D and E.[43] In particular, non-users decline from 9% of people earning less than £200 per week to 0% of people earning more than £1000 per week. Correspondingly, non-users are more likely to live in social housing: in 2008 70% of people who live in social housing did not use the Internet, and they accounted for 28% of all those who were not online. Again, there is a significant overlap with the older and disabled groups alluded to above.

[42] The Manifesto of Race Online 2012 (supported last year by the Prime Minister) states: "By the end of this Parliament, everyone of working age should be online and no one should retire without web skills" (Race Online 2012, 2010).
[43] The classification is the usual one (Market Research Society, 2006).

The Oxford Internet Surveys (carried out every two years since 2003) provide far more detail on adoption and use of the Internet. Interestingly, they have identified a group of around 5% of adults who are "ex-users" that have previously been connected but are so no longer. According to the recent survey, around half of these would like to use the Internet in future and one third plan to do so within the next year (Dutton et al., 2011).

Ensuring that adults can and do use the Internet is a very important objective in building Digital Britain, as discussed in BIS (2010). The Race Online 2012 initiative was set up to pursue this objective, under the strapline "We're all better off when everyone's online", following much work on identifying and combating digital exclusion such as DCLG (2008). The point of view underlying the strapline is supported by, for instance, a report (PricewaterhouseCoopers, 2009), which showed benefits of £900 million per year purely from shifting online one government contact a year per unconnected adult, and estimated aggregate benefits of getting everyone online at £22 billion. The Equality and Human Rights Commission is also tracking Internet connection and use, as an indicator of social inclusion and participation (Jones, 2010).

The Race Online 2012 partnership programme was launched in early 2010, when there were 10 million adults who had never been online, with £30 million of government funding to get 1.7 million more adults online by the end of 2012. The programme's focus is the 4 million adults who are both digitally excluded and socially excluded. Its approach has been to sign up large numbers of partners who support its goals and pledge to contribute to achieving them. Contributions take many forms, including public internet access centres, training and support, tailored software, and motivational and publicity material – all of which can be provided on any scale, from national down to local. Half-way through the programme's life, 1.3 million more people had already gone online, so its efforts could be said to have been a great success. Of course, it is impossible to say how far this change is attributable to the programme and how far to other factors. However, it is clear that:

- Even if Race Online 2012 exceeds its targets, around 8 million adults will remain offline at the end of 2012.
- The task of getting more people online becomes progressively more challenging, as people with some inclination to go online will do so first (whether through market or non-market mechanisms), and those who remain offline increasingly are offline for a strong reason.

Some potential ways of getting more people online are sketched in Section 5.1.

2.6 An Open Internet

The details of how users will use superfast broadband are unclear. However, we can assume at least that entertainment, social networking and user-generated content will figure large. In doing so they will tend to supplant passive viewing of television with active involvement and to extend ties between people. They will also evidently affect the returns to service providers and might well reduce the digital divide. In this section, though, we look at some implications of broadband use that have significant effects on the market economy and society as a whole but that can create problems, or opportunities, for service providers.

The capacity, and ease of use, of today's smart phone outstrips that of yesterday's personal computer. Users are buying and using ever more powerful communications and computing devices in ever larger numbers. The computational capacity of the devices is an enormous resource that can be put together in volunteer computing, when volunteers co-operatively support distributed computing applications useful to society. As observed by Benkler (2006), this is possible because individual users have unimpeded access to the Internet and own devices that have higher capacities than the users can use effectively for their own purposes.[44]

Similarly the "spare" mental capacity of individual users is put together with that of other users in Wikipedia creation, open source software development, and specialised online advice, for example. In all these cases, as with volunteer computing, individual choices, often motivated by the satisfaction of the task itself, are harnessed for collective ends. Besides these collective undertakings there are also many individual actions; for instance, besides large open source software developments there are many free small programs that people have developed and distributed just because they felt the need.

This individual ownership of powerful communications and computing devices is one cause of the spectacular growth of Internet applications. Other causes, which are equally relevant to this paper, are the expectations that communications are largely unconstrained by price and that content is free (or, failing that, paid for by advertisers and their customers).

Thus society benefits if users buy communications and computing capacity in discrete quantities that are larger than they need and if users do not feel constrained in using bandwidth and obtaining or delivering content. In the past this has been achieved for the Internet by charging simple flat rates for broadband and by not imposing differential charging on, or impeding the delivery of, particular lawful content.[45] These conventions ensure that the Internet is an 'open network', in which users can obtain and deliver whatever lawful content they want without feeling constrained by considerations of price or quality.

However, service providers are introducing support system functions that make bandwidth availability more finely grained. These functions are introduced both to adjust the return to the investment more precisely and to respond to implicit user requirements (because managed IP services, not "best effort" Internet access, might be needed to make quality high enough to meet the expectations of users with demanding applications). These functions are not going to disappear when fast broadband gives way to superfast broadband: returns on investments will become harder to determine and demand for bandwidth might still outstrip supply, even if we do not as yet know the details of how the bandwidth will be used.

[44] Benkler (2006) provides a fuller account, which discusses also the legal and institutional implications. Zittrain (2008) does likewise, but with more emphasis on the ability of device suppliers such as Apple to close off access to new applications and thereby hinder innovation by others.

[45] By 'differential charging' we mean charging different content providers different amounts when the contents being delivered receive the same quality of service. In the US it is sometimes called 'tiered access'. Among ways of impeding the delivery of content (and, in particular, of impeding Internet access) are blocking it entirely, placing difficulties in its way, and degrading its quality of service to a level that prevents a satisfactory user experience.

Flat rate charging is simple and therefore appealing to many; to that extent it might help in reducing the digital divide. However, arguably it is not very fair, as it treats users alike, even if they have very different levels of usage. Also, it tends to favour the better-educated, and therefore richer, members of society, because usually they are the ones who use their "spare" communications and computing to create Wikipedia, develop open source software, and so on. The practical importance of these disadvantages of flat rate charging is unclear, but ideally they would not exist.

Including objectives intended to reduce the digital divide, there are therefore various potentially conflicting objectives in charging for Internet use:

- Keeping the Internet as an open network.
- Getting users to pay their fair contributions.
- Providing capacity for demanding applications.
- Encouraging people to become Internet users.
- Avoiding subsidies from poorer Internet users to richer ones.

The first of these might seem to point to flat rate charging. The second and third point to more finely grained charging. Such charging would help to ensure efficient use of capacity; if designed carefully, it could, we believe, also fulfil the fourth and fifth objectives. We discuss this further in Sections 4.4 and 5.2. In short, we consider that well-designed pricing plans and certain forms of traffic management can contribute usefully to satisfying existing users and to attracting new users.

At the same time there are practices that might be claimed to help with traffic management but that could be undesirable from the national perspective, because they could hinder innovation by new content providers and lead to discrimination against particular content providers.[46] The most widespread of these practices are:

- Charging different content providers different amounts for the same quality of service.
- Encouraging the exclusive use of managed IP services by impeding Internet access.

Thus to ensure that the Internet is an open network, service providers should not impose differential charging on, or impede, the delivery of particular lawful content to users. This does not preclude the use of micropayments as charges for content, if there is no pressure on content providers to charge and no discrimination against content from other providers. Also, it does not preclude traffic management designed to ensure a satisfactory user experience: for instance, voice and video traffic might need to be given priority if there are capacity limitations. It does, however, entail having a view on what constitutes a satisfactory user experience when technologies and expectations might be changing faster than regulations, so reserve powers to set the minimum quality of service could be difficult to implement.

[46] This is argued by Lee et al. (2009) and Plum (2011), for example. A contrary view is put forward at length by Sidak (2006).

Much of this is recognised in statements on net neutrality by the EC (EC, 2011c) and Ofcom (Ofcom, 2011i), as well as in the suggestions by the Body of European Regulators for Electronic Communications (BEREC) on quality of service (BEREC, 2011a) and transparency (BEREC, 2011b). However, they do not yet propose a code of practice, which could state such general principles and specific instances to help to maintain the Internet as an open network that can promote innovation. Such a code of practice might be like the guidelines for Internet neutrality of Norway (Post-og-teletilsynet, 2009), which were signed by the major Internet service providers, some major content providers, industry organisations, the consumer ombudsman and the consumer council. It would also be in line with the guidelines in France (ARCEP, 2010), which reserve the term "Internet access" for services that offer full access to the Internet, free from impediment.

There are already two relevant codes of practice in the UK, for describing broadband speeds (Ofcom, 2010c) and for describing traffic management effects (BSG, 2011). The second of these builds on the first. The code of practice mooted above would build on the second: instead of just describing traffic management effects, signatories would forgo use of the practices mentioned above. Ofcom considers that market forces should be enough to ensure that service providers do not impede Internet access (Ofcom, 2011i); in that case all service providers should be willing signatories to the code of practice.

3. GOVERNMENT POLICY AND INDUSTRY IMPLEMENTATION

This chapter looks at superfast broadband mainly from the national perspective, seen as a reflection of the interest of the government in the market economy. However, policies are devised with costs, and therefore technologies, in mind even though they strive to be "technology neutral". Consequently the chapter first discusses the relevant technologies.

Terms such as 'fast broadband', 'superfast broadband', 'ultrafast broadband' and 'next-generation broadband' tend to be used without the distinctions between them being clear. The clear distinctions are those between network technologies. However, these do not necessarily translate into distinctions between service capabilities, because the capabilities depend on other factors, such as geography and population density, and are continuing to develop under the pressure of competition. Investment decisions by the industry are determined largely by the available technologies; the policy objectives of the government relate broadly to capabilities. These investment decisions, policy objectives and technologies are summarised in this chapter.

Different definitions of 'superfast broadband' abound; one, fairly common, one requires downlink speeds greater than 50 Mb/s. In several countries there are governments and service providers intent on achieving such speeds. In the UK, however, Ofcom takes 'superfast broadband' to be broadband with downlink speeds greater than 24 Mb/s. To avoid confusion, in this paper we follow the practice of Ofcom but mention other usage where necessary.[47] More fully:

- Basic broadband is expected to provide downlink speeds of up to 2 Mb/s.
- Fast broadband is expected to provide downlink speeds between 2 Mb/s and 24 Mb/s.
- Superfast broadband is expected to provide downlink speeds of at least 24 Mb/s.

These downlink speeds fit the investments needed for the associated implementation technologies in the BT network. In that network, moving from basic broadband to fast broadband entails a modest capital outlay, while moving from fast broadband to superfast broadband entails a very much larger outlay. For other networks, with more limited coverage, and other technologies, such as those of Virgin Media, there are very different profiles of investment as take-up develops.

[47] For instance, the usage in the European Digital Agenda (EC, 2010a) is different: its "fast broadband" has downlink speeds of at least 30 Mb/s and its "ultrafast broadband" has downlink speeds of at least 100 Mb/s. Moreover, for its Urban Broadband Fund (DCMS, 2011i) the government appears to be taking "ultrafast broadband" to have downlink speeds between 80 Mb/s and 100 Mb/s

3.1 Network Technologies

In the BT network:

- Basic broadband is delivered over copper, with Asymmetric Digital Subscriber Line (ADSL). ADSL can support downlink speeds of up to 8 Mb/s (before allowing for signalling overheads, line limitations and so on) and uplink speeds of up to 1.4 Mb/s, but for many premises the downlink speeds are likely to be below 2 Mb/s.
- Fast broadband is delivered over copper, with ADSL2+. ADSL2+ can support downlink speeds of up to 24 Mb/s (before allowing for signalling overheads, line limitations and so on) and uplink speeds of up to 3.3 Mb/s, but for many premises the downlink speeds are likely to be below 12 Mb/s.[48]
- Superfast broadband is delivered over copper, with VDSL2, or over fibre. VDSL2 is the most recent form of Very high speed Digital Subscriber Line (VDSL), from the cabinet to the premises. VDSL2 can support downlink and uplink speeds of up to 100 Mb/s; different frequency plans permit symmetric and asymmetric downlink and uplink speeds. More fully, for delivery of superfast broadband over copper or fibre:
  - Fibre To The Cabinet (FTTC) uses VDSL2 over copper from a cabinet to each of the premises and shares between multiple premises the capacity of one fibre from the exchange to the cabinet.
  - Fibre To The Premises (FTTP) using a Gigabit Passive Optical Network (GPON) has a fibre from a splitter to each of the premises and shares between multiple premises the capacity of one fibre from the exchange to the splitter.[49]
  - FTTP using a Point-To-Point fibre (PTP) has a fibre all the way from the exchange to each of the premises.

In the Virgin Media network:

- Superfast broadband can be delivered using Hybrid Fibre Coax (HFC). An HFC network resembles an FTTC network, in that it shares between multiple premises the capacity of one fibre to a cabinet, but the connection from the cabinet to the premises uses coaxial cable for cable television.[50] For

[48] Indeed, in 2011 in the UK the average modem synchronisation speed of fixed broadband connections in the UK was 7.5 Mb/s (Ofcom, 2011g). The downlink speed observed by the user could well be 10% less than that.

[49] For FTTP using a GPON the fibre from the exchange is shared to a point that is not necessarily in a cabinet. Also, to ensure that enough premises are served, there might be two points in the path from the exchange to the premises where the fibre is split; the second of these might be in the chamber or on the pole that would otherwise provide the distribution point for copper to all the premises in a cluster. The split might result in 32 paths at one splitter and eight paths at the other. The aggregate downlink speed can be 2488.32 Mb/s and the aggregate uplink speed can be 1244.16 Mb/s upstream in the ITU standards, so 32 paths would obtain on average 77.76 Mb/s downstream and 38.88 Mb/s upstream each (ignoring overheads).

[50] Telephony is provided along with cable television, but it uses copper, not coaxial cable.

broadband, a HFC network provides downlinks and uplinks by using the coaxial cable according to the European version of the DOCSIS 3.0 standards.[51]

- The capacity of an HFC network is limited both by the sharing of the fibre upstream from the cabinet and by the dependence on coaxial cable downstream from the cabinet towards the premise. The coaxial cables can be replaced by a GPON (in a use of "radio frequency over glass" technology): in the cabinet the signals to the premises are separated and the signals from the premises are combined.

The capacity of a terrestrial wireless network depends not only on the radio system, but also on the number and types of cells, the locations of the users, and the spectrum bands used. Thus comparisons between wireline and wireless technologies can be misleading. Nonetheless it is worth noting that in principle:

- High Speed Packet Access (HSPA) and its Evolution (HSPA+) support, in theory, downlink speeds of up to 42.2 Mb/s (in a 5 MHz channel).[52]
- Long Term Evolution (LTE) supports, in theory, downlink speeds of up to 163.2 Mb/s (in a 10 MHz channel).[53]
- LTE Advanced has targets of 100 Mb/s for high mobility and 1 Gb/s for low mobility, which exploit aggregated carriers and Multiple-Input Multiple-Output (MIMO) antenna systems.[54]

A potentially attractive implementation in certain areas is to use fibre to a distribution point where there is an antenna and to use wireless signals to the premises from the antenna. If just the final segments of the local loop are wireless, the signals could have short range and therefore avoid interference by having low power or high frequencies; currently licence-exempt devices are used for this purpose in some rural areas. Other possible devices that could avoid interference without having such limited ranges are those that exploit the "white spaces" in television channels (typically between 470 MHz and 790 MHz).[55]

The preferred choice now of satellite systems for broadband has satellites operating in the K_a frequency band, with spot beams directed to particular areas to allow reuse of channels.[56] Such satellites use smaller dishes and less crowded spectrum than those operating in the K_u frequency band, which is used widely for broadcasting. They offer downlink speeds between 0.5 Mb/s and 10Mb/s and uplink speeds between 0.1 Mb/s and 2 Mb/s (but round-trip delays of at least 500 ms, due to the 35,000 Km path lengths).

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[51] The European version of the DOCSIS 3.0 standards specifies a maximum downlink speed of 55.62 Mb/s and a maximum uplink speed of 30.72 Mb/s. Four or eight channels may be bonded, giving a downlink speed of up to 444.96 Mb/s and an uplink speed of up to 245.76 Mb/s.

[52] For instance, a network in Spain currently provides downlink speeds of up to 21.8 Mb/s in theory and 16.2 Mb/s in practice, with uplink speeds of up to 5.7 Mb/s (Vodafone, 2011).

[53] In a test of a lightly-loaded commercial LTE network in Finland, the average downlink speed was 36.1 Mb/s for LTE and 4.1 Mb/s for HSPA, the average uplink speed was 1.7 Mb/s for LTE and 0.3 Mb/s for HSPA, and the average latency was 23 ms for LTE and somewhere between 98 ms and 189 ms for HSPA (Epitiro, 2011).

[54] In demonstrations LTE Advanced has provided 900 Mb/s using 60 MHz of spectrum obtained by aggregating 20 MHz channels and using 8x8 MIMO systems. (Ericsson, 2011).

[55] These devices are undergoing trials for broadband applications in Bute and Cambridge (http://cwst.org.uk).

[56] K_a band satellites covering the UK are provided by Astra (3B), Avanti (Hylas) and Eutelsat (KaSat).

3.2 Government Policies

The main government plan for broadband offers "Britain's Superfast Broadband Future", with the aim of ensuring that Britain had the "best superfast broadband network" in Europe by 2015 (DCMS, 2010b). The phrase "best superfast broadband network" remains to be defined: the government is to adopt a scorecard which focusses on composite measures of speed, take-up, coverage, price and choice, and Ofcom expects to publish the data for the scorecard in the middle of 2012 (Treasury, 2011).

The plan re-affirms a commitment to ensure that virtually all premises have access to a "minimum" service offering a downlink speed of 2 Mb/s by 2015 (so the "minimum" service can be equated with fast broadband); the previous target date was 2012.[57] There is also a target of achieving 90% superfast broadband coverage by 2015 (DCMS, 2011a). In summary, the government targets are that the UK should have:

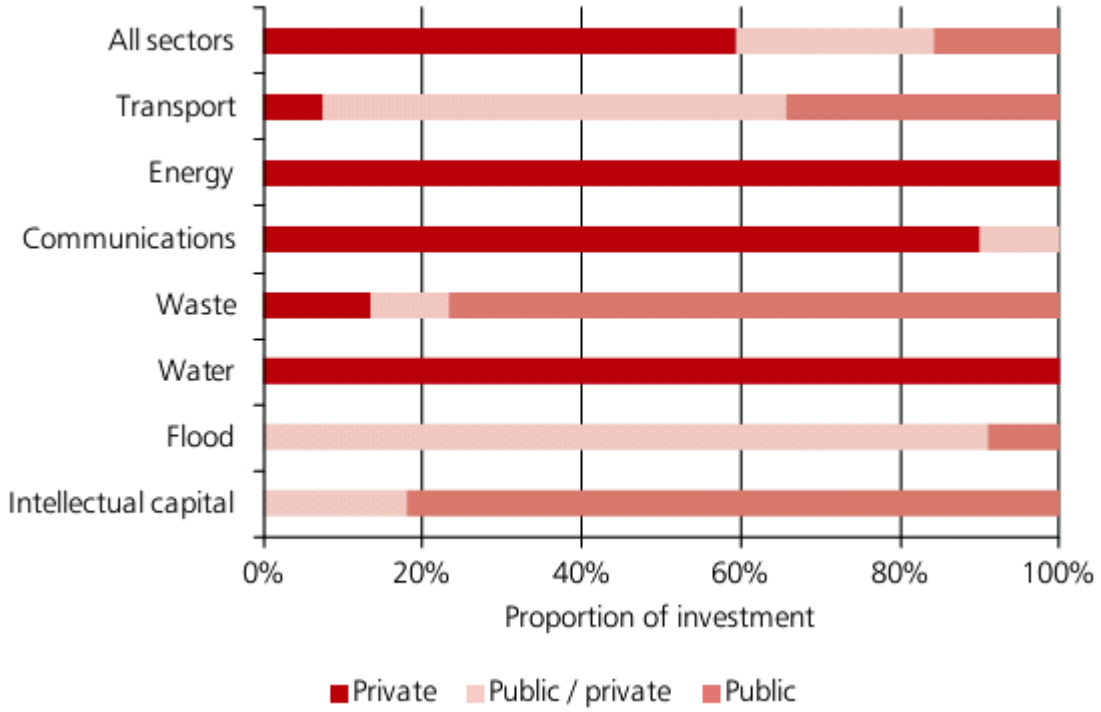
- 100% fast broadband coverage by 2015.
- 90% superfast broadband coverage by 2015.
- The best superfast broadband network in Europe by 2015.

The plan commits the government to making available £530 million, primarily for infrastructure in remote areas (as opposed to awareness campaigns, for example) by 2015.[58] It also indicates that there could be a further £300 million by 2017, and suggests that the European Regional Development Fund (ERDF) could provide up to £100 million, alongside or in the matching funding that local authorities need to arrange (Treasury, 2011). For comparison, the 3G spectrum auctions of 2000 raised £22.5 billion for the government. As Figure 3.1 shows, the government envisages that much of the investment foreseen over the next few years in communications will be privately funded. Also, that investment is dwarfed by the investments in energy and transport, as Figure 3.2 makes clear.[59]

[57] The plan says "We remain committed to ensuring virtually all homes will have access to a minimum level of service of 2 Mb/s by 2015" and "Access to a basic service of 2 Mb/s remains the minimum level of service that we feel is acceptable" (DCMS, 2010b). As it also says "The Commission target is for all EU citizens to have access to a basic level of broadband (2 Mb/s) by 2013", the government target is one for 100% fast broadband coverage by 2015, not 100% basic broadband coverage by 2015: "up to" 2Mb/s is not seen as enough.

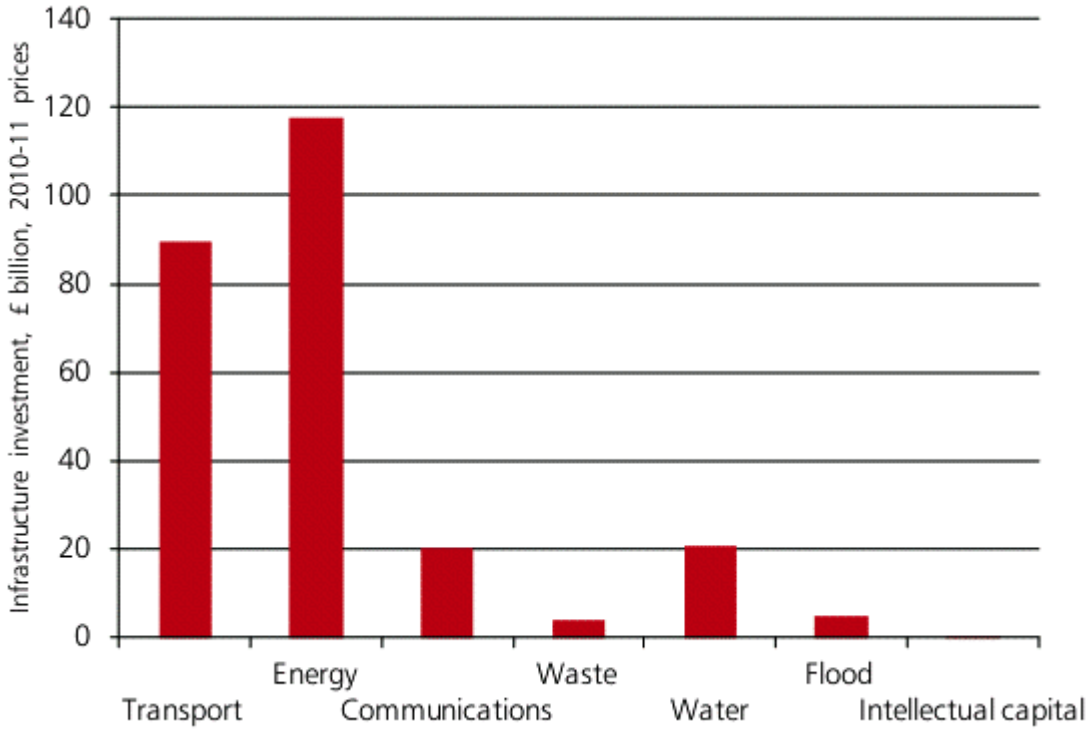
[58] Of this, £230 million comes from the underspending on digital switchover and £150 million is taken from BBC licence fee receipts annually for two years from 2013; a further £150 million may be taken annually for two years until 2017, giving £830 million in total.

[59] Though the investments in energy and water are referred to as being "privately funded", they are paid for substantially by regulated increases in the tariffs of the companies concerned. These sources of funds are classed as private, while BBC licence fee receipts, for example, are classed as public.



Source: Treasury (2011), Chart5.A.

Figure 3.1: Sources of funding for infrastructure investments



Source: Treasury (2011), Chart 6.A.

Figure 3.2: Pipeline of projected infrastructure investments

The government funding for broadband is distributed to local authorities and devolved administrations, which determine the balance between supporting fast broadband and supporting superfast broadband. Initially local authorities submitted bids for the funding; after receiving eighteen bids the government approved six projects in England and one project in Scotland, amounting to perhaps £100 million from the £530 million.[60] Subsequently the government allocated the funding without overt competition between local authorities: it allocated £294.8 million to England, £68.8 million to Scotland, £4.4 million to Northern Ireland and £56.9 million to Wales.[61] To obtain their allocations, the local authorities in England are obliged to arrange matching funding from their own resources (and possibly EU funds); the devolved administrations for Scotland, Northern Ireland and Wales are expected to do likewise. The gap in investment is then to be filled by the private sector, probably by matching the total public funding (DCMS, 2011g).

The funding was allocated indicatively to groups of local authorities (in England) and to the devolved administrations (for Scotland, Northern Ireland and Wales) according to the modelled cost of providing fast and superfast broadband to the "white areas" where broadband coverage was poor and state aid could be provided under EU rules (EC, 2009). The cost model used (DCMS, 2011c) is much more detailed than that discussed in Section 4.1. The sums awarded range between about £25 (in Surrey) and about £81 (in Shropshire), with an average of £47, for each of the premises in the white areas in England. Certain local authorities were initially reluctant to take up the funding on the grounds that they would have many extra costs that would not be covered even if they matched the government funding, but almost all have now put forward their plans (DCMS, 2012b).

Part of the £530 million contributes to the Rural Community Broadband Fund of £20 million (DEFRA, 2011). This is intended to let communities outside the 90% coverage areas have superfast broadband services if they can demonstrate local need or demand, feasibility and cost-effectiveness. It may provide up to 50% of project costs (except for maintenance costs), with a ceiling of £300 for each of the premises; the remaining funding must come from private sources.

Additional government funding, forming an Urban Broadband Fund of £100 million, is to be shared between up to ten cities to develop broadband access with downlink speeds between 80 Mb/s and 100 Mb/s (DCMS, 2011i). The cities are London, Edinburgh, Cardiff and Belfast, as well as the winning bidders in a competition open to UK cities that have more than 150,000 dwellings.[62] The Urban Broadband Fund can be considered for capital expenditure on:

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[60] The projects that won the initial bidding are for Devon and Somerset, Norfolk, Wiltshire, Cumbria, Herefordshire, North Yorkshire and Highlands and Islands, as described in DCMS (2010a) and DCMS (2011b). The first approved projects that draw on the subsequent allocation to England are for Suffolk and Rutland; the Rutland one is intended to test the feasibility and viability of providing superfast broadband to 99% of the 15,000 dwellings in Rutland, by supplementing the £710,000 of government funding with £1,290,000 from other sources (DCMS, 2011h).

[61] The sums take account of existing public funding for South Yorkshire, Cornwall and Northern Ireland and likely private sector investment in Greater London, as confirmed in DCMS (2011d), DCMS (2011e) and DCMS (2011f).

[62] These cities are Birmingham, Bradford, Bristol, Glasgow, Leeds, Liverpool, Newcastle, Nottingham, Manchester and Sheffield.

- Stimulating private sector investment.
- Providing broadband where commercial service providers will not do so.
- Ensuring the availability of downlink speeds between 80 Mb/s and 100 Mb/s, particularly for Small or Medium-sized Enterprises (SMEs), where commercial service providers will not do so.
- Extending high-speed wireless connectivity (through public WiFi, for example).
- Helping to create SMEs that could grow by using enhanced broadband connectivity.

The European Digital Agenda (EC, 2010a) lays downs targets for the EU in various areas (broadband penetration, digital inclusion, e-government, e-commerce, research and innovation, and the low carbon economy). To start its implementation there is now a draft funding plan for ratification by the Council of Ministers and the European Parliament (EC, 2011b). This plan envisages that an investment of £225 billion (from private and public sources) would be needed to meet the targets throughout the EU and proposes that the EU spend between £5.8 billion and £7.7 billion to enhance broadband penetration by exploiting EU structural funds as well as programmes by individual countries and companies. Its targets for broadband penetration are that all EU Member States should have:

- 100% basic broadband coverage by 2013.
- 100% coverage at 30 Mb/s (or more) by 2020.
- 50% of households subscribing to Internet connections at 100 Mb/s (or more) by 2020.

The government has not yet put forward plans for reaching these targets. The targets for 2020 could be ambitious: one requires 100% coverage by superfast broadband and the other requires 50% take-up (not just coverage) at even higher speeds. The relevant deployment costs are considered in Section 4.1 for current technologies, but by 2020 much could have changed. Already there are various ways in which coverage can be increased; for instance, BT can make technical improvements to FTTC (using vectoring, bonding and, perhaps, phantom mode, as mentioned in Section 3.4) or introduce fibre to the distribution point (with VDSL or short range wireless thereafter). However, whether service providers feel justified in making such investments, and whether 50% of households subscribe to these connections, could depend on the rate of adoption of superfast broadband: even rapidly expanding uses of communications, such as social networking, have taken four years to be adopted by 50% of subscribers (Ofcom, 2011b).

3.3 Regulatory Activities

Open access makes a network accessible to multiple service providers, who thereby both share the costs and compete for customers; by contrast, closed access is provided by single large suppliers and does not enhance competition. Where investment by several providers is unlikely, open access should be attractive to society as a whole, despite its inevitable complications for billing and other business support systems. It can let different premises have different service providers in the following ways:

- Ethernet, or another layer in the transmission hierarchy higher than the physical layer, can be controlled by different service providers from an exchange. This “bit stream” access, provided in the

FTTC and FTTP variants of the Generic Ethernet Access (GEA) product of BT, does not give the service providers full flexibility in service definition and pricing.

- The physical transmission to different premises can be controlled by different service providers from a cabinet, in Sub-Loop Unbundling (SLU). For FTTC using VDSL, then, different premises can have different service providers because they have different copper lines. This might be expensive, especially if duct sharing (between the exchange and the cabinet) is infeasible or expensive.
- The physical transmission to different premises can be controlled by different service providers from an exchange, in Local Loop Unbundling (LLU). This option is not currently available in the UK for FTTC or FTTP, though it is available for copper lines and EU work (EC, 2010b) suggests that it should be available for dark fibre. Under it:
    - For FTTC using VDSL different premises can have different service providers only if they are served by different fibres from the exchange (because, for example, they are served from different cabinets).
    - For FTTP using GPON different premises can have different service providers only if they are served by different fibres from the exchange (because, for example, they are served by different GPONs).
    - For FTTP using PTP different premises can have different service providers in all circumstances.
- The physical transmission to different premises can be provided by different service providers sharing common physical infrastructures, such as ducts and poles.

BT has regulatory obligations to make available limited forms of open access: it must provide on non-discriminatory terms wholesale products that can be used in the implementation of broadband (Ofcom, 2010a). In particular:

- Virtual Unbundled Local Access (VULA) lets communications providers use BT electronics and physical infrastructure, with control similar to that achieved when taking over the physical lines. BT is required to make GEA, in both its FTTC and its FTTP variants, conform with the requirements for VULA. The prices for VULA must be “fair and reasonable”.
- SLU lets communications providers take over the physical lines between cabinets and premises. BT is required to make SLU available for copper lines from cabinets at cost-oriented prices for use, in particular, with VDSL.
- LLU lets communications providers take over the physical lines between exchanges and premises. BT is required to make LLU available for copper lines from exchanges at cost-oriented prices for use, in particular, with ADSL.
- Physical Infrastructure Access (PIA) lets communications providers use BT ducts and poles when laying their own fibres between exchanges, cabinets and premises. BT is required to share detailed information with other communications providers about, for example, the available capacity and quality of ducts and poles. The prices for PIA must reflect the costs of providing it (with a recognition of investment risk where new ducts or poles are needed for superfast broadband).

The government intends to let Ofcom require infrastructure sharing to encourage efficient investment in infrastructure or promote innovation, even in the absence of Significant Market Power (SMP).

Also, where infrastructure is constructed with the aid of public funds, the infrastructure operators are expected to offer open access on fair, reasonable and non-discriminatory terms.

Ofcom also plans to make spectrum available for LTE, partly by exploiting the spectrum made available by digital switchover. In its first consultation (Ofcom, 2011d) it proposed to:

- Auction 250 MHz (equivalent to three quarters of the spectrum used by mobile service providers in the UK today) at 800 MHz and 2.6 GHz.
- Keep some of the 2.6 GHz spectrum for multiple low-powered uses sharing the same frequency bands in different parts of the country.
- Oblige one 800 MHz licence holder to provide, by the end of 2017, an area where 95% of the population lives a sustained downlink speed of 2 Mb/s with a 90% probability of indoor reception.
- Authorise the use of LTE at 900 MHz, 1.8 GHz and 2.1 GHz as well as at 800 MHz and 2.6 GHz.
- Ensure that annual charges for the 900 MHz, 1.8 GHz and 2.1 GHz spectrum are consistent with the results of the auction of 800 MHz and 2.6 GHz spectrum.

After that consultation, in the next consultation (Ofcom, 2012) Ofcom proposed a choice of coverage obligation on one 800 MHz licence holder: there would be either an obligation to provide 98% coverage of the population (instead of the 95% of the first consultation) or an obligation to provide coverage comparable with that of current 2G services combined with that of mobile voice services delivered through the Mobile Infrastructure Project where that infrastructure could support 4G mobile data services.[63] Either of these obligations should go a long way to covering those areas in which terrestrial wireless broadband is viable.

However, Ofcom does not expect to hold the auction until late in 2012, so commercial deployment will not occur until late in 2013.[64] By contrast, there are commercial LTE offerings from the major service providers in Germany, Spain and Sweden and there have been auctions in Italy and France. The sums raised in these auctions are modest compared with those raised in 3G spectrum auctions, but, as Table 3.1 demonstrates, they exceed the UK government funding for broadband deployment: they suggest that the auction proceeds in the UK for the 800 MHz spectrum alone would be between £1.1 billion and £2.5 billion.[65]

[63] The Mobile Infrastructure Project has government funding of £150 million. It is intended to improve the coverage and quality of mobile services for the 5%-10% of consumers and businesses in the UK where existing coverage is poor and thereby ensure coverage for 99% of the UK population (DCMS, 2012a).

[64] Meanwhile BT and Everything Everywhere are conducting a trial of LTE in Cornwall; one hundred fixed and one hundred mobile connections are being tested to understand the flexibility of LTE to both fixed and mobile services on the same infrastructure (Everything Everywhere, 2011).

[65] The coverage obligation proposed by Ofcom for one 800 MHz licence holder is not unlike that imposed in Germany, for example, so the suggested auction proceeds already take account of it.

Table 3.1: Auction proceeds from the 60MHz digital dividend in the 800 MHz frequency band			
Country	Auction proceeds (£ million)	Population (million)	Auction proceeds per person per MHz (£)
Germany	2986.4	81.6	0.61
Spain	1089.9	47.7	0.38
Sweden	164.7	9.3	0.30
Italy	2471.6	60.5	0.68
France	2203.6	64.9	0.57

Source: Announcements by relevant regulators and ministries.

Ofcom also intends to make wireless devices that operate in the white spaces in the television frequency bands licence-exempt, so that such devices could be used for broadband and machine-to-machine communications (Ofcom, 2011h). The frequencies that would become available might amount to 150 MHz (around two fifths of the spectrum used by mobile service providers today) between 470 MHz and 790 MHz. In areas where there was no unacceptable interference these frequencies could be very useful in providing different ways of trading power off against range.

In the longer term, the government expects to release at least 500MHz of frequencies below 5.0 GHz from public sector holdings, some harmonised for mobile communications (Treasury, 2011). These include:

- 160MHz at 2.3 GHz-2.4 GHz and 3.4 GHz-3.6 GHz in 2016, with a further 40 MHz in 2020.
- 150MHz at 2.7 GHz-3.1 GHz and 4.4 GHz-5.0 GHz (potentially).

3.4 Network Programmes

Openreach claims to have passed 7 million premises with what it calls 'superfast' broadband and expects to pass 10 million premises (36% of the premises in the UK) in 2012 (BT, 2012b). It intended to pass 18 million premises (66% of the premises in the UK) by the end of 2015, at a cost to BT of £2.5 billion (BT, 2011a); however, it later brought forward the target date for premises passed from 2015 to 2014 (BT, 2012b).[66] During the deployment coverage in individual exchange areas is patchy initially: it extends to only between one third and two thirds of the premises in the larger exchange areas. About three quarters of the deployment will provide FTTC, with downlink speeds of up to 40 Mb/s (and plans for 80 Mb/s) and uplink

[66] The figure of 19 million premises has sometimes been quoted, but 18 million is consistent with being 66% of the premises in the UK in 2007, when there were 27.2 million premises and the investment planning began.

speeds of up to 15 Mb/s (and plans for 20 Mb/s).[67] The remainder will provide FTTP, generally using GPON, with downlink speeds of up to 100 Mb/s (with trials of 300 Mb/s) and uplink speeds of up to 30 Mb/s.[68]

Virgin Media claims to have passed over 6.5 million homes with what it calls "ultrafast" broadband and expects to pass almost 13 million homes (50% of the homes in the UK) by the middle of 2012 (Virgin Media, 2011a).[69] The service uses the cable television infrastructure and is therefore not scheduled to be available throughout all the UK or even in all urban areas. The downlink speeds are up to 100 Mb/s (with trials of 200 Mb/s) and the uplink speeds are up to 10 Mb/s.[70]

Fujitsu, in collaboration with Virgin Media, TalkTalk and Cisco, has stated its willingness to spend between £1.5 billion and £2.0 billion on giving access to fibre to at least 5 million homes over the next 5 years, if it obtains about £500 million of the government funding (Fujitsu, 2011). It proposes to use BT ducts and poles but to provide FTTP instead of FTTC where possible. Though the 5 million homes are said to be "rural", they are not all clearly outside the areas to be covered by the current BT programme. Providing FTTP inside those areas would enhance competition but would not help to achieve 90% coverage by superfast broadband.

Not all companies are attracted by the government funding. In particular, Geo has decided not to take part in bids for it (Geo 2011a). Its objections to the funding arrangements (Geo, 2011b) are that:

- Subsidising the gap in investment automatically favours an incumbent that has the security and knowledge of revenue streams on its current network.
- The public sector does not underwrite the risks of the private sector or guarantee revenues to the private sector (through public private partnerships, for example).
- The use of BT ducts and poles by other service providers is subject to uncertain terms and pricing and is not permitted for backhaul, wireless connections and business leased lines.
- BT and winners of the government funding are not currently required to offer dark fibre to other service providers.

[67] The capacity can be increased further: speeds of 300 Mb/s at 0.4 Km and 100 Mb/s at 1.0 Km from cabinets can been reached by combining vectoring (which cancels noise), bonding (which uses the spare copper pairs provided to many premises) and phantom mode (which uses the "phantom" signals in multiple copper pairs). The BT intention is to use vectoring, which can achieve speeds of 100 Mb/s at 0.4 Km and 40 Mb/s at 1.0 Km (if the lines from the cabinet are co-ordinated and have good quality) and bonding.

[68] The downlink speed is now said to be up to 110 Mb/s (instead of 100 Mb/s), but this 10% improvement is unlikely to make further applications realistically feasible. Similarly the trial speed is now 330 Mb/s (instead of 300 Mb/s) (BT, 2012b).

[69] The UK had 25.4 million households in 2007 and 26.0 million households in 2010 (ONS, 2011a). These are groups of people who have the same main residence and share at least one main meal per day or living accommodation. We take households to correspond with homes.

[70] The downlink speed is now going up to 120 Mb/s (instead of 100 Mb/s), which keeps it slightly higher than that from BT (Virgin Media, 2012).

Nonetheless some service providers have not been deterred: CityFibre currently operates fibre networks for local authorities and businesses, and now intends to invest up to £500 million to build further metropolitan networks and FTTP networks in towns and cities across the UK (CityFibre, 2011).

There are also three projects underway, funded partly by the ERDF, to make superfast broadband access available to hundreds of thousands of premises. They are seen as attempts to revitalise regional economies, and as such attract public funding as well as private funding. In them:

- 80% of premises in South Yorkshire are to have access to superfast broadband by the middle of 2012, funded by about £90 million from the ERDF, local authorities and the private sector. If revenues permit, coverage will be extended to 97% of premises, thereby increasing it from about 388,000 premises to about 462,000 premises (http://www.digitalregion.co.uk/isp-area/background-to-the-network-design). This "Digital Region" project lays new fibre to new street cabinets with VDSL2 ports leading to BT street cabinets and thence to customer premises.
- Between 80% and 90% of premises in Cornwall are to have access to superfast broadband, funded by up to £53.5 million from the ERDF and up to £78.5 million from BT (BT, 2010).
- 88% of premises in Northern Ireland are to have access to superfast broadband, funded by about £18 million from the ERDF and £29.8 million from BT (BT, 2011b).

Several much smaller projects (typically serving hundreds of premises) are being built or planned; a survey for Ofcom (Analysys Mason, 2011) describes about twenty. They mainly fall into the following classes[71]:

- Rural communities having local enthusiasts using private and public funding.
- Urban areas seeking economic revitalisation using private and public funding.
- Urban sites being redeveloped or reconditioned using private funding.

These projects offer economies of scale when one organisation provides service to multiple communities or sites. The organisation might therefore aim to have national scope, either as a conventional company, such as Rutland Telecom (which is now majority-owned by Gigaclear), or a Community Interest Company (CIC), such as NextGenUs (which has deployed fibre and WiMax in several counties, from Cumbria to Somerset).[72]

Having looked at the government funding, regulatory changes and some outline implementation plans we turn in the next chapter to the deployment costs, the operating costs (including some one-off costs) and the returns to the service providers.

[71] The FTTP project in Bournemouth does not fall into these classes. It is privately funded and intended to serve tens of thousands of premises, However, it has had a very chequered history, with a change of ownership, a suspension of operations, tales of poor quality street works, and investigations of alleged fraud by the former owners. It is now rebuilding its reputation under the ownership of CityFibre.

[72] CICs are intended to benefit specific communities and are therefore legally constrained. The profits distributable as dividends and the dividends per share are limited (but can be carried forward for four years). Also, their assets are "locked": they can be transferred only to another asset-locked organisation (which is typically a CIC or a charity).

4. COSTS AND RETURNS TO SERVICE PROVIDERS

This chapter looks at superfast broadband mainly from the perspective of service providers, which (like other businesses) are concerned with their costs and returns.

There is by now a fair amount of evidence about the costs of deploying superfast broadband, derived from both actual deployments and theoretical studies. They tend to converge on fairly similar numbers; the convergence is not good enough to give confidence in the fine details of a business case, but it is good enough to choose between broad investment policies, at least if those policies result in operating costs resembling each other.

Even if the costs were known to fine levels of detail, the returns to the service providers would not be. The returns depend on patterns of use, which can change when a new application arises, when take-up reaches a critical mass, or when many non-users of the Internet are won over.

In this Chapter we look at these costs and returns, not by reviewing several possible cost predictions but by focussing on certain cost predictions that can be made sufficiently consistent with each other to allow choices to be made. We also discuss the returns that might be possible. Any estimates of the returns are necessarily loose, but we can discuss what applications might generate the returns and how service providers can manage network capacity and boost demand to make use of superfast broadband.

4.1 Deployment Costs

Substantial publicly available studies of the costs of superfast broadband provision in the UK have been conducted for the Broadband Stakeholder Group (BSG) and for Ofcom. They could, in principle, be updated with implementation experience since they were produced; however, their broad conclusions appear fairly firm, even if the detailed numbers which we derive with their help are not completely right.

The best known of these studies (Analysys Mason, 2008) deals with fibre deployments with FTTC or FTTP, where FTTC uses VDSL and FTTP uses GPON or PTP. If the service is taken up by 25% of the premises to which it is available, the costs, derived much as in the study, are those shown in Table 4.1.[73]

[73] The take-up of 25% is designed to be comparable with that for wireless technologies given below. The resulting costs are not those provided immediately by the study, which assumes that there is roughly 31% take-up of superfast broadband (representing 40% of premises where cable broadband is not available or not taken up). In other respects the costs are based on the assumptions made in the base case of the study; in particular, there is no use of Virgin Media or utility infrastructure, no rental charge for reusing existing ducts and poles, no replacement of the copper infrastructure (on providing FTTP), and no need for engineering work inside the premises. By the "incremental" cost given on a row in this and succeeding tables is meant the cost averaged over the move to that row from the preceding row.

Table 4.1: Costs of superfast broadband deployment based on fibre												
Proportion of premises that could be served	Total deployment cost (£ billion)			Incremental deployment cost (£ billion)			Incremental deployment cost per premises connected (£)			Incremental deployment cost per premises passed (£)		
	FTTC using VDSL	FTTP using GPON	FTTP using PTP	FTTC using VDSL	FTTP using GPON	FTTP using PTP	FTTC using VDSL	FTTP using GPON	FTTP using PTP	FTTC using VDSL	FTTP using GPON	FTTP using PTP
68%	2.2	9.4	11.2	2.2	9.4	11.2	471	2045	2424	118	511	606
90%	3.6	16.8	20.0	1.4	7.4	8.8	949	4912	5900	237	1228	1475
97%	4.3	20.7	24.7	0.7	3.9	4.7	1410	7526	8946	353	1882	2236
100%	4.8	23.3	27.7	0.4	2.6	3.0	2530	14900	17100	633	3725	4275

Source: Analysys Mason (2008) with our interpolations and calculations.

Deviations from the base case do not affect the main implications of these figures, which are:

- Providing superfast broadband to the first 90% of premises in the UK costs two thirds as much again as providing it to the first two thirds.[74]
- Providing superfast broadband to the first 97% of premises in the UK costs roughly twice as much as providing it to the first two thirds.
- FTTC using VDSL costs roughly one quarter as much as FTTP using GPON and one fifth as much as FTTP using PTP.[75]
- If FTTP is to be adopted then the use of PTP instead of GPON should be considered seriously, as the cost increment could be offset by other factors, such as future-proofing, operational convenience and regulatory simplicity.[76]

The hardware and software costs associated with VDSL resemble those associated with DOCSIS 3.0.[77] However, deploying FTTC entails providing new fibres to cabinets, while enhancing the cable television infrastructure to support superfast broadband does not do so. Consequently the costs of deploying FTTC are much greater than those of enhancing the cable television infrastructure. However, if broadband using the cable television infrastructure became very popular, the cabinets would need to serve more premises and would need to be provided with extra fibres, so the costs of enhancing the infrastructure would grow.[78] This could happen sooner rather than later, as the Virgin Media cabinets tend to have larger serving areas (in terms of premises passed) than the BT cabinets.

[74] The two thirds include inner London, cities with more than 200,000 inhabitants (such as Glasgow, Leeds and Manchester) and the central portions of towns, both large (such as Banbury, Doncaster and Neath) and small (such as Southwold, Llangollen and Pitlochry).

[75] However, for greenfield sites large enough to justify having splitters, the cost of FTTP using GPON should exceed that of FTTC using VDSL by at most the extra cost for customer premises equipment, which might be £100 for each of the premises connected.

[76] Because a GPON does not use active electronics, sharing a GPON between different broadband service providers entails using, for example, VULA from a point further into the network.

[77] They might be between £50 and £100 for each of the premises connected.

[78] Moreover, coverage by the cable television infrastructure is limited even in its chosen urban areas. It might need to undergo extension in those areas, as in Southampton, for example (Virgin Media, 2011b).

The costs of wireless technologies have also been studied for the BSG (Analysys Mason, 2010a). They depend heavily on the demands that people place on the network. The study for the BSG of wireless technologies distinguishes three usage scenarios (A, B and C), with usage scenario C perhaps the closest to what might be expected from the use of FTTC.[79] If the service is taken up by 25% of the premises to which it is available, the costs, derived much as in the study, are those shown in Table 4.2.[80] The terrestrial wireless technology considered in these costs is the one that in the study is cheapest overall, involving 50 MHz of spectrum at 3.5 GHz; however, the study notes that many factors, including the prices and sizes of the spectrum to be awarded by Ofcom in various bands, could change the "best" choice of wireless technology.

Table 4.2: Costs of superfast broadband deployment based on wireless technologies

Proportion of premises that could be served	Total deployment cost (£ billion)						Incremental deployment cost (£ billion)						Incremental deployment cost per premises connected (£)					
	Terrestrial wireless			Satellite			Terrestrial wireless			Satellite			Terrestrial wireless			Satellite		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
68%	4.9	14.2	30.3	9.4	52.5	108.8	4.9	14.2	30.3	9.4	52.5	108.8	260	760	1617	500	2800	5800
90%	6.4	17.9	38.3	12.3	68.7	142.3	1.5	3.7	8.0	2.9	16.2	33.5	260	640	1380	500	2800	5800
97%	6.9	19.2	40.9	13.2	74.0	153.3	0.5	1.2	2.6	1.0	5.3	11.1	280	640	1380	500	2800	5800
100%	7.4	20.1	42.2	13.6	76.3	158.1	0.5	0.9	1.3	0.4	2.3	4.7	627	1117	1587	500	2800	5800

Source: Analysys Mason (2010a) with our interpolations and calculations

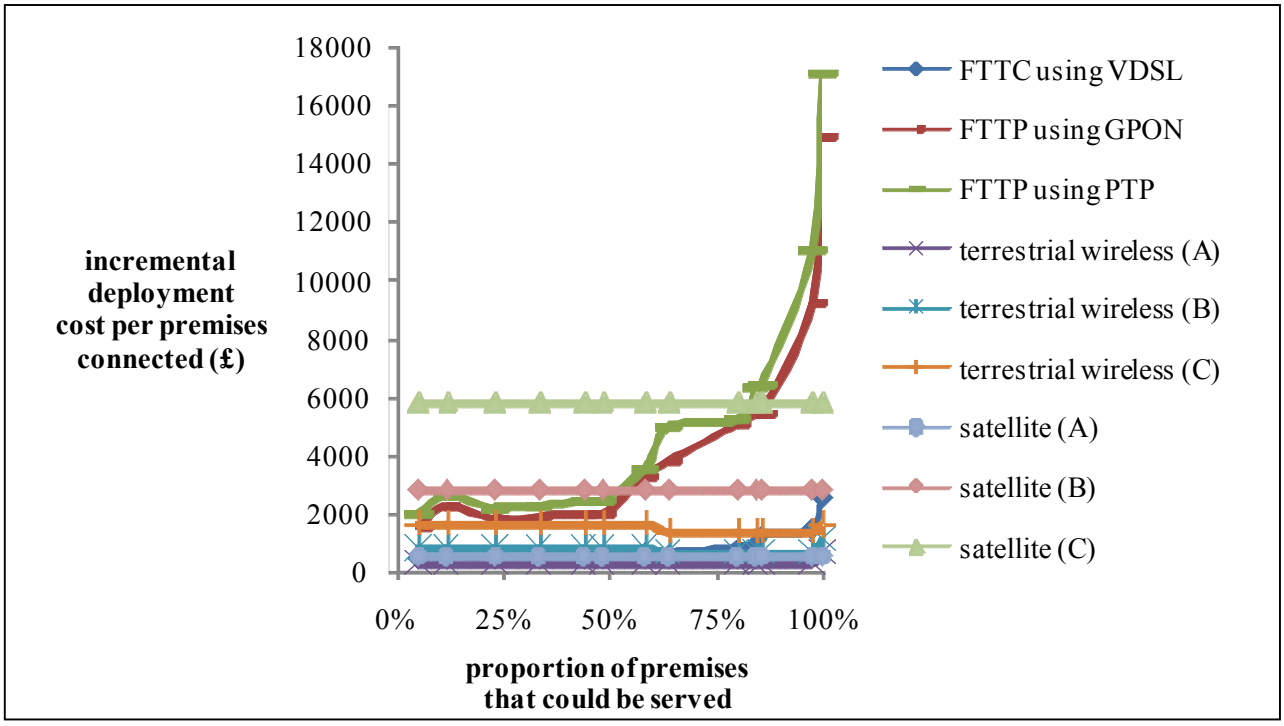
Among the implications of the results, including these tables, are:

- Providing terrestrial wireless broadband could be cheaper throughout the UK than providing FTTC if usage follows scenario A.
- Providing terrestrial wireless broadband could be cheaper for some portion of the final third of premises than providing FTTC if usage follows scenario B.
- Providing satellite broadband could be cheaper for some portion of the final third of premises than providing FTTC if usage follows scenario A.

Accordingly, beyond 90% coverage service providers envisage the use of wireless technologies. Terrestrial wireless might not reach 100% coverage without various relaying techniques, so satellites would be needed to move from 97% coverage to 100% coverage. Some possible costs are shown in Figure 4.1 and, in the most relevant cases, Figure 4.2. These costs are even more tentative than those above: several wireless technologies (including LTE, white space radio and WiFi) are being considered for different situations.

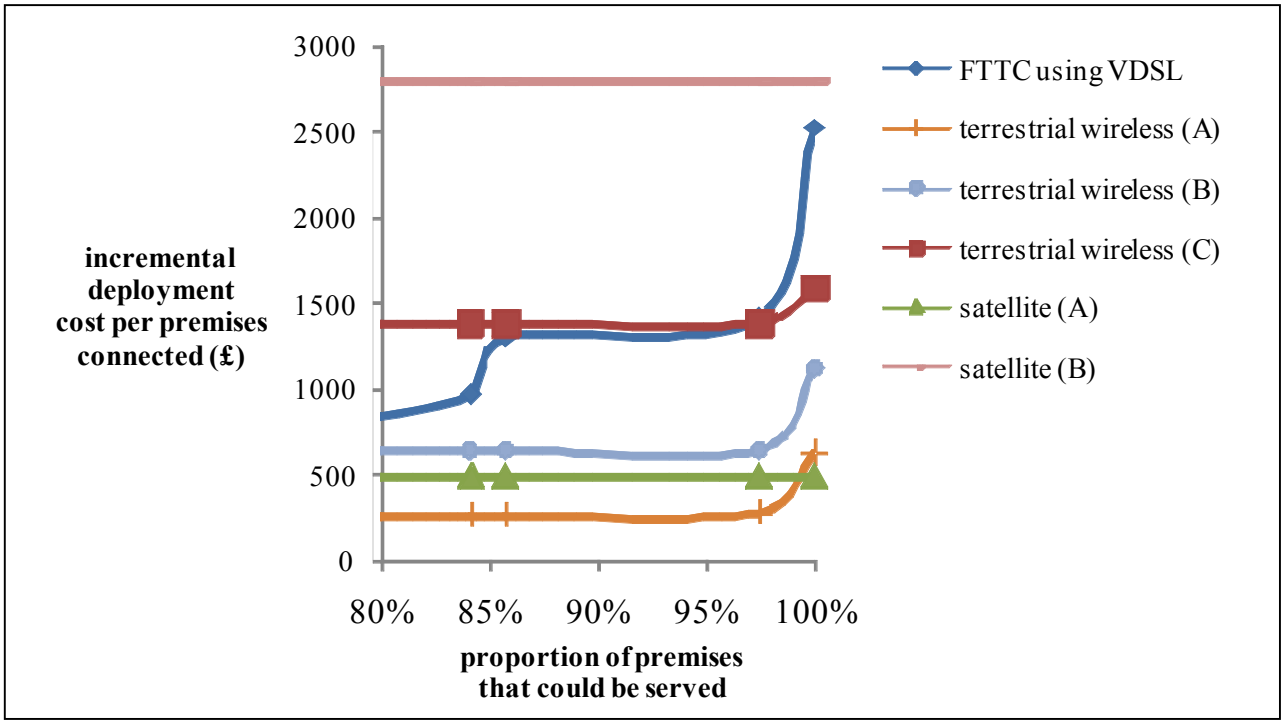
[79] Very loosely, A represents an evolution from current mobile broadband levels of usage, B represents an evolution from current fixed broadband levels of usage (with ADSL2+) and C is similar to effective use of VDSL2. In fact for each of the premises the average demand (which in aggregate constrains the capacity of a terrestrial base station) is assumed to be 85 Kb/s for A, 711 Kb/s for B and 1.5 Mb/s for C and the peak demand (which in aggregate constrains the coverage by a terrestrial base station) is assumed to be 4.6 Mb/s for A and 19.0 Mb/s for B and C.

[80] Again the base case depends on many other assumptions, such as the absence of optimisation of downloading and uploading requirements through time-shifting or satellite caching and a ratio of 8:1 between downlink time slots and uplink time slots.



Source: Analysys Mason (2010a) with our adaptations and calculations

Figure 4.1: Costs of superfast broadband deployment based on fibre or wireless technologies (ranging over all proportions of premises served and technologies used)



Source: Analysys Mason (2010a) with our adaptations, interpolations and calculations

Figure 4.2: Costs of superfast broadband deployment based on fibre or wireless technologies (considering just certain proportions of premises served and technologies used)

4.2 Funding Requirements

At this point we can see how the funds being made available from public sources according to Section 3.2 align with the targets of the government, which are:

- **100% fast broadband coverage by 2015**. This presents problems somewhat similar to those of a target for 100% superfast broadband coverage: the last 10% of premises are difficult to reach. According to BT ADSL2+ (for fast broadband) was available to 75% of premises in 2011, but current plans stretch no further than early in 2013, when it should be available to 90% of premises.[81]
- **90% superfast broadband coverage by 2015**. This is widely regarded as the target most likely to give rise to a funding gap that the private sector must fill. However, as it has the same time scale and public sources of funding as the target for 100% fast broadband coverage, where the funding gap lies depends on the priorities in the areas where the funding is allocated.
- **The best superfast broadband network in Europe by 2015**. This is not well enough defined yet to be examined further. Its definition is expected to be consistent with the targets of the European Digital Agenda (DCMS, 2011g).

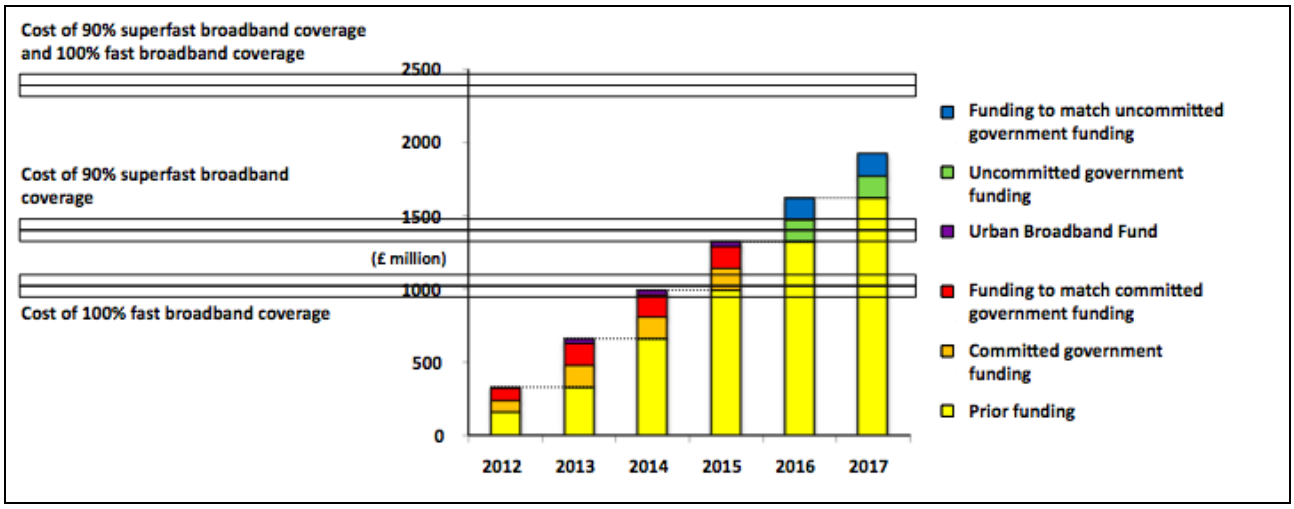
We concentrate here on the first and second of these targets, but before doing so we discuss briefly the targets of the European Digital Agenda, which are:

- **100% basic broadband coverage by 2013**. This could be attained: In 2011 in the UK all BT exchanges except some in Na h-Eileanan an Iar (the Western Isles), representing 99% of the total, could provide broadband connections, though for many exchanges there is only one retailer of broadband and there are premises too far away to receive high quality service (Ofcom, 2011g).[82]
- **100% broadband coverage at 30 Mb/s (or more) by 2020**. This is like a target for 100% superfast broadband coverage by 2020. The indicative costs for 100% coverage in Section 4.1 will be invalid in 2020, when other technologies will be available. For instance, already technical improvements to FTTC (using vectoring, bonding and, perhaps, phantom mode, as mentioned in Section 3.4) might provide 50 Mb/s to 75% of premises, so 30 Mb/s might be accessible to even more premises.
- **50% of households subscribing to Internet connections at 100 Mb/s (or more) by 2020**. This could be attained by 50% coverage and 100% take-up (if, for example, all Virgin Media customers took the service), at one extreme, or 100% coverage and 50% take-up, at the other. As even popular services take several years to reach 50% take-up, the most likely interpretation of the target involves very high coverage, such as 90%, if not 100%. There are several developments that could contribute to achieving very high coverage at 100 Mb/s by 2020; they include LTE Advanced (as described in Section 3.1), technical improvements to FTTC, and fibre to the distribution point (with VDSL or short range wireless thereafter). At this stage the likely mix of these, and the costs, are unknown.

[81] In 2011 86% of broadband connections in the UK offered downlink speeds of at least 2 Mb/s (Ofcom. 2011g).
[82] For comparison, at least 98.5% of homes in the UK can receive terrestrial television and 99.7% are expected to be able to receive digital terrestrial television to some extent (Ofcom, 2007).

Figure 4.3 compares the expected public funding with the costs of deployment given in Section 4.1. In it:

- "Prior funding" refers to the sum of the public funding (including EU funds) to provide superfast broadband in previous years (including that for South Yorkshire, Cornwall and Northern Ireland).
- "Committed government funding" refers to the £530 million taken from the underspending on digital switchover and the BBC licence settlement for 2013-2014 and 2014-2015.
- "Uncommitted government funding" refers to the £300 million taken from the BBC licence settlement for 2015-2016 and 2016-2017.
- The government funding is assumed to be matched from other public sources and distributed in approximately annual portions.
- Any EU funds provided are assumed to be included in the matching funding.
- Superfast broadband is assumed to be deployed to 68% of premises without public funding.
- Fast broadband is assumed to be needed only for 10% of premises (as the remainder will obtain superfast broadband).



Source: Study calculations.

Figure 4.3: Expected cumulative public funding for broadband deployment

For Figure 4.3 the costs of reaching the targets are as follows:

- **100% fast broadband coverage by 2015**. If there is 90% superfast broadband coverage, 100% fast broadband coverage can be obtained simply by providing fast broadband to the final 10% of premises. This would probably be done using wireless technologies, with network planning according to scenario A or B of Section 4.1. The cost might therefore be about £1.0 billion, in accordance with Table 4.2. This estimate is higher than those noted in a recent study of the cost of extending LTE networks to achieve 98% or 99% coverage in the 800 MHz frequency band (Real Wireless, 2012); however, it is lower than those implied by the detailed study results themselves.
- **90% superfast broadband coverage by 2015**. The BT programme to pass 18 million premises, mentioned in Section 3.4, will cater for about 68% of premises by the end of 2014. The figures in Table 4.1 suggest that obtaining 90% superfast broadband coverage, starting with 68% coverage, would cost about £1.4 billion. This estimate seems to be lower than that envisaged by BT when it

said that, beyond its existing programme, it could match government funding of up to £830 million to reach 90% coverage (BT, 2011a).

These calculations suggest that the overall cost of reaching both targets could be £2.4 billion. By the end of 2015 about £1.3 billion of public funding (including the matching funding that local authorities and devolved administrations need to find, and the prior funding for South Yorkshire, Cornwall and Northern Ireland) will have been spent. This is unlikely to be enough to ensure both 100% fast broadband coverage and 90% superfast broadband coverage: on the basis of these figures, to reach both targets by then there has to be an extra £1.1 billion, which is the funding gap that the private sector needs to fill.

However, these figures should be treated very cautiously for at least the following reasons:

- They are calculated using gross national models, though the margin of doubt and scope for variations at local levels are immense. For instance, the local broadband plan for Suffolk assumes that the total public funding is matched by private funding but assigns only a quarter, not a half, of the funding to ensuring 100% fast broadband coverage (Suffolk County Council, 2011).[83]
- They focus on deployment costs, though the public sector would incur associated costs, such as those for procurement, programme management and demand stimulation. Devoting public funding to them (which is permissible for all the funding except the Urban Broadband Fund) would decrease the public funding available for offsetting deployment costs and increase the private funding needed.
- They depend heavily on take-up (which is assumed to be 25% in Section 4.1).

As an illustration of the uncertainty, the expected cost of superfast broadband deployment in the Highlands and Islands is only known to be "between £200 million and £300 million" (HIE,2012); this is so even though deployment is due to start in 2013, BT is the only supplier still negotiating (because Cable and Wireless, Fujitsu and Commedium have withdrawn on the grounds that the business case was too weak) and there have been various earlier government-aided broadband deployments in the Highlands and Islands.

The BT programme assumes the predominant use of FTTC. However, the Fujitsu programme (with Virgin Media, Talk Talk and Cisco) described in Section 3.4 proposes the predominant use of FTTP, which is more problematic. If, as it suggested, Fujitsu spent between £1.5 billion and £2.0 billion, along with £500 million of government funding, on giving access to fibre to at least 5 million homes, then it would be spending between £400 and £500 per home passed; on the basis of the figures in Table 4.1 this sum would be enough for FTTC, but not enough for FTTP outside the areas of the country covered in existing BT plans.[84]

[83] By contrast, the assumption in Rutland seems to be that the government, local public and private contributions are roughly equal.

[84] On our calculations, the rental charges for ducts and poles could be about £3 for FTTC and £16 for FTTP (per home passed per year) while, if no existing ducts and poles were used, installing new ducts and poles could cost about one hundred times this (per home passed).

4.3 Operating Costs

As indicated in Section 4.1, FTTP using PTP might cost 20% more than FTTP using GPON.[85] However, it has the advantage of both offering more capacity and of lending itself more readily to open access. Be that as it may, the primary emphasis of BT in the UK is on the deployment of FTTC using VDSL and FTTP using GPON, and, though in principle SLU is available, prices for duct and pole sharing have yet to be accepted.[86] The main BT wholesale prices, which determine the costs of other service providers, are therefore those for GEA. They are summarised in Table 4.3.[87]

Table 4.3: Prices for GEA in 2011

Downlink speed "up to"	Uplink speed "up to"	Annual rental per line (£)			Connection charge per line (£)	Cessation charge per line (£)
		FTTC	FTTP when the service provider also provides telephony on BT copper	FTTP when the service provider does not also provide telephony on BT copper		
40 Mb/s	2 Mb/s	82.80	Same as that for FTTC	100.68 more than that for FTTP when the service provider also provides telephony on BT copper	80.00	5.37
	10 Mb/s	88.80				
	15 Mb/s	119.40				
100 Mb/s	15 Mb/s		154.80			
	30 Mb/s		436.82			

Source: Openreach price list (http://www.openreach.co.uk/orpg/home/products/pricing/loadProductPrices.do?data=Po3KnmqvCqPyVFu37aLXIdpyYOJW58IELJ3a1hFsXScqDWVqEbA2PDlT5Y2OhxKv).

Ofcom does not require the prices for GEA to be cost-oriented, on the grounds that GEA must compete with existing local access services (such as LLU for copper lines) and the investment in FTTC and FTTP is risky. Accordingly BT has set a minimum contract duration (of one year) for GEA.

However, Ofcom requires the prices for SLU and LLU (and indeed the prices for duct and pole access) to be cost-oriented. The main BT wholesale prices for SLU and LLU are given in Table 4.4, on the assumption of

[85] WIK (2010) provides an alternative analysis (for a hypothetical EU country) which narrows the difference in cost to 10%. It also indicates that the consumer surplus is between 10% and 20% higher if open access is provided by FTTP using PTP than if it is provided using FTTP using GPON, but inevitably its calculation makes many assumptions.

[86] In fact in the middle of 2011 roughly 300 cabinets per week were being equipped to handle GEA while only 700 cabinets in total were equipped to handle SLU (BT, 2011c).

[87] Strictly speaking, the speeds and prices for FTTP are just most of those for brownfield sites; for greenfield sites there are other options. The figure of £100.68 is £3.00 less than wholesale line rental (which provides telephony using BT copper lines, exchanges and back office facilities). Also, several special offers (for example, waiving connection charges), and some other charges (for example, the one-off payment of £2000 for connection to the BT equipment in the exchange) are ignored.

using a Shared Metallic Path Facility (SMPF), in which the copper line is shared so that BT provides telephony and another service provider provides broadband.[88]

Table 4.4: Prices for SMPF in 2011					
Annual rental per line (£)		Connection charge per line (£)		Cessation charge per line (£)	
SLU	LLU	SLU	LLU	SLU	LLU
11.47	14.70	115.00	39.79	100.67	5.37

Source: Openreach price list (http://www.openreach.co.uk/orpg/home/products/pricing/loadProductPrices.do?data=%2Bs55xT91%2FPruY0Pxlyi4HVnqs1m6OcKz301sgolk8P2FdiaKKPEfrCsJCb3sZkzJ).

The costs assigned by BT to the SMPF and the Metallic Path Facility (MPF) variants of LLU are in Table 4.5.[89]

Table 4.5: Costs of LLU in 2010-2011		
Basket	Component	Annual cost per line (£)
MPF	New provides	10.48
	Single migrations	12.63
	Bulk migrations	1.07
	Ceases	1.34
	Rentals	89.74
	Total	115.26
SMPF	New provides	7.76
	Single migrations	3.16
	Bulk migrations	1.15
	Ceases	1.72
	Rentals	15.23
	Total	29.02
Comingling	Room builds	2.64
	Hostel rentals	8.61
	Tie cables	3.33
	Rounding	0.14
	Total	14.72

Source: BT (2011f) with our classification and averaging.

The original prices for access to BT ducts and poles proposed by BT took three months to develop and were immediately attacked by competitors as being four or five times higher than the underlying costs. They were reduced and restructured following nine months of trials (BT 2011g). The restructuring makes the reduction difficult to estimate in percentage terms, but arguably the prices have been halved. For ducts they now vary between £1.34 per metre and £0.44 per metre, depending on the number of cables that the duct carries. For poles they now range upwards from £11.24, depending on the number of users that the pole serves.

[88] The connection charge was reduced slightly following a complaint to Ofcom that it included irrelevant costs (and is waived in certain exchanges); the cessation charge was not challenged officially at the same time (Ofcom, 2011f).

[89] The "comingling" basket is split between SMPF lines and MPF lines in proportion to their numbers of lines. A different assignment of costs is likely to emerge from an Ofcom review (Ofcom, 2011e), which might well increase the proportion of costs assigned to SMPF over a period.

On the basis of these tables and various other figures the annual operating costs per line to service providers for the access segments of various broadband services can be determined. Assuming that where the access segment terminates in a BT exchange, equipment is 80% filled, and one-off costs are recovered over five years, the annual operating costs (aside from support systems costs) are as follows:

- For superfast broadband using FTTC GEA (with a downlink speed "up to" 40 Mb/s) the annual cost is between £105 and £140 per line, depending on the uplink speed. This is made up from:
  - The GEA prices.
  - The costs in the exchange (taken to be like the LLU tie cable costs or the GEA cable link price when there are 120 lines served).
- For superfast broadband using SLU SMPF the annual cost is about £110 per line (assuming that there are, say, 120 lines served in a cabinet 2 Km from the exchange). This is made up from:
  - The SLU prices.
  - The costs of VDSL multiplexors and related equipment (taken to be £1500 per multiplexor with 24 ports).
  - The costs of cabinets (taken to be £12000 per cabinet).
  - The costs of electricity (taken to be £0.10 per kWh, with a requirement for 4W per line).
  - The costs of rented ducts to the exchange (taken to be £1000 per cabinet per year).
  - The costs of installed fibre to the exchange (taken to be £4000 per cabinet).
  - The costs in the exchange (taken to be like the LLU tie cable costs).
- For fast broadband using LLU SMPF the annual cost is about £55 per line. This is made up from:
  - The LLU costs.
  - The costs of ADSL multiplexors and related equipment (taken to be £1000 per multiplexor with 24 ports).

The costs for superfast broadband using SLU SMPF are sensitive to the assumptions about the number of lines served. A large BT telephony cabinet has about 480 lines, so a superfast broadband cabinet having 120 lines represents 25% take-up of superfast broadband.[90] Even a large service provider might not achieve this in competition with others, though several providers sharing a cabinet might do so.

For comparison we note that the operating costs of wireless technologies per premises served, as estimated for the BSG (Analysys Mason, 2010a), are as follows:

- For terrestrial wireless the annual cost is about £7, £62 or £150 per premises served, depending on which scenario (A, B or C) is adopted.
- For satellite the annual cost is about £3, £18 or £38 per premises served, depending on which scenario (A, B or C) is adopted.

[90] For comparison, for LLU in 2010-2011 there were 12,845 "hostels" in BT exchanges housing equipment for other service providers, and 7,202,518 LLU lines (BT, 2011d). This equates to 561 LLU lines per exchange served for each service provider, if each service provider has one hostel per exchange served.

To be made strictly comparable with the figures for FTTC using VDSL above, these figures would need to be increased with counterparts to the LLU costs for general support and general management given in BT (2011f). Doing this might add £20 to them. In all cases the figures would remain those for the annual operating costs of the access segment, not of the entire service.

4.4 Returns

As noted in Section 4.1, for Virgin Media superfast broadband can use fibres that are already laid to the cabinets, so it is relatively inexpensive to deploy, at least unless the service becomes very popular. For BT this is not so. Moreover, if BT customers start to demand bandwidth beyond the 100 Mb/s limit of VDSL, BT will have the further costs of providing fibre to the premises (as will Virgin Media, ultimately). The expected costs are, however, by now moderately well understood and publicised. By contrast, the expected returns to the service providers are not well known and remain difficult to quantify: some relate to intangible matters such as the reputations of the service providers, and others depend on the uses that people make of services that are still rare in many countries and that are likely to have non-linear growth when take-up crosses their critical thresholds.

Nonetheless on the basis of the assumptions and calculations in Section 4.3 we can place lower bounds on what those returns need to be if superfast broadband is to pay its way. Under those assumptions, the "typical" operating cost per customer of superfast broadband is somewhere between £50 per year and £85 per year more than that of fast broadband (provided that the support systems are essentially the same and the one-off costs of fast broadband are fully depreciated). This suggests that the price to a customer for superfast broadband will be at least somewhere between £80 per year and £135 per year more than that of fast broadband (allowing for miscellaneous expenses, profit margins and value-added tax).[91]

A report (Arthur D Little et al., 2011), in an annual series for telecommunications service providers, noted a widespread assumption that consumers would be willing to pay for simultaneous access to multiple high-speed devices, such as high-definition televisions. Indeed this was assumed in defining usage scenarios B and C in Section 4.1. Even so, another report (Digital TV Research, 2011) suggested that in the UK there were unlikely to be more than 1 million customers for paid-for versions of IP television (using managed IP services instead of "best effort" Internet access). Meanwhile at the end of 2011 BT had 679,000 subscribers for its IP television service (though it originally envisaged having two or three million by 2010) and 400,000 subscribers for its superfast broadband service (BT, 2012a).

[91] In practice the difference in price appears to be typically £120 per year, perhaps with an installation charge, but it could fall as more service providers offer superfast broadband.

To put this in perspective, the revenues for different retail communication services are summarised in Table 4.6.[92] A relatively small shift in preference, from television subscription to Internet subscription, could generate enough revenues to cover the costs of incremental superfast broadband deployment. As Table 4.7 indicates, such a shift will happen, albeit not very fast, if young people keep their communication habits as they become older.

Table 4.6: Revenues for communications in 2010

Service	Component	Annual revenues from consumers and businesses (£ million)
Television broadcasting	Advertisements	3486
	Public funding	2792
	Subscriptions	4839
	Others	630
	Total	11747
Radio broadcasting	Advertisements	438
	Public funding	685
	Total	1123
Fixed telephony	Total	9300
Mobile telephony	Total	10600
Fixed data	Total	6500
Mobile data	Total	4500

Source: Ofcom (2011b).

Table 4.7: Preferences for communications in 2010

Age	Service likely to be most missed if it disappeared			
	Television broadcasting	Radio broadcasting	Internet access	Mobile data and telephony
16-24	23%	3%	26%	28%
25+	44%	10%	17%	13%

Source: Ofcom (2011b).

Nonetheless, so far the evidence from other countries in the EU is that consumers will not pay much more for superfast broadband than for other broadband. For instance, as early as 2008 FTTP prices were comparable with ADSL2+ prices in six out of nine EU countries considered (Tariff Consultancy, 2009). Likewise, the first survey by Ofcom of superfast broadband users (Ofcom, 2011b) suggested a low willingness to pay a high premium for the service: the most important reason for changing to superfast broadband was getting value for money.[93]

[92] For the data services there are also annual revenues of £4080 million for advertisements, but those pass to the content providers, such as Google and Facebook, not to the service providers (Ofcom.2011b).

[93] However, in the US Verizon charges $40 per month for ADSL with downlink speeds of "up to" 15 Mb/s, $55 per month for FTTP with downlink speeds of "up to" 15 Mb/s and $145 per month for FTTP with downlink speeds of "up to" 50 Mb/s.

In the Ofcom survey most superfast broadband users were satisfied with their change to superfast broadband (despite the extra expense) and reported improved Internet experiences, including more responsive browsing. These users had increased their streaming of high definition and standard definition television programmes and films, and, to some extent, their video calling, file sharing and online gaming; however, the nature of their online activity had not yet changed fundamentally.[94] Of course, they were early adopters and might therefore not give a good representation of future use. However, the broad brush projections in Table 4.8 point in a similar direction.[95]

Table 4.8: Projected traffic growth in the UK in 2010-2015

Traffic type	Compound annual growth rate in 2010		Compound annual growth rate in 2010-2015	
	For consumers	For businesses	For consumers	For businesses
Internet	39%	19%	39%	23%
Fixed data	38%	18%	37%	19%
Mobile data	128%	107%	86%	76%
IP video	65%		52%	
IP television	300%		78%	
IP video on demand	37%		26%	
IP wide area networking		18%		19%
IP video conferencing		56%		56%
IP telepresence				16%

Source: Cisco VNI forecast highlights (http://www.cisco.com/web/solutions/sp/vni/vni_forecast_highlights).

On the basis of these, and related, projections, in the UK in 2015 consumer IP video traffic could be 73% of consumer IP traffic and mobile IP video traffic could be 68% of mobile IP traffic (which itself would be 9% of IP traffic). The characteristics of video traffic will be crucial in maintaining margins for service providers.

There is a possibility that consumers will move faster than these projections assume to new applications that need high uplink speeds as well as high downlink speeds or that need very high downlink speeds.[96] For instance:

- Cloud computing could support file storage, personal video recording, office applications, language translation, and speech and image recognition, especially for mobile users, and complex computations for clusters of sensors and other devices with limited processing powers. There might

[94] If MPEG-4 coding is used, high definition and standard definition television require downlink speeds of about 10 Mb/s and 2 Mb/s (respectively) for streaming, and 10 gigabytes and 2 gigabytes (respectively) might be downloaded during the viewing of an entire full length film. Superfast broadband is needed for these applications only if there are multiple simultaneous viewings per household, the uplink is used heavily (perhaps for high quality video), or fast broadband falls well below its intended downlink speed (perhaps because of poor wiring, or the use of WiFi, inside the house).

[95] Some of the IP traffic, especially for businesses, is due to managed IP services and is not strictly Internet traffic. Also, "IP television" and "IP video on demand" are subtypes of "IP video" (but not of each other).

[96] If these applications are to be adopted, the implications for privacy should be considered carefully first, especially as the users and the servers might be in different jurisdictions. Already the use of Google Apps for holding any personal data has been rejected by various local authorities.

even be a move towards those online gaming systems in which images for games are produced on, and transmitted from, remote servers.

- Very high quality video entertainment, collaboration and communication could take many forms, such as three-dimensional virtual worlds, meeting places and games with 'real people' instead of avatars. Displaying three-dimensional images requires only software upgrades to many current computers, so it could easily become widespread sooner on computers than on televisions.

However, earlier predictions have not always been fulfilled; for instance, despite widespread expectations to the contrary, the growth of peer-to-peer traffic, through file sharing and user content generation, has not led to much closer alignment between downlink and uplink speed requirements (though the adoption of peer-to-peer video calls could still make it do so). Also, speaking to consumers about how they would use superfast broadband is likely to result in direct extrapolation from what they do currently. In short, from the perspective of the service provider, the business case for superfast broadband is largely untested.

However, the deployment of superfast broadband is happening, and the revenue per bit transmitted is likely to fall faster than the cost per bit transmitted. How, then, can service providers improve their margins? An overall strategy might include the following tactics for managing network capacity and boosting demand:

- **Ensuring fair charging for use.** Very low proportions of users are responsible for very high proportions of the traffic (with 10% of users being responsible for 90% of the traffic in some cases). Tiered pricing for users could reflect the differences in investment needed as well as encourage take-up by reluctant users.
- **Reducing rush hours**. Video traffic has a higher peak-to-average ratio than other traffic and is increasing faster than other traffic, so it is making peak traffic grow faster than average traffic. There is a stronger case than ever for encouraging off-peak activity, through time-of-day pricing and the provision of applications for time-shifting downloads and uploads.
- **Preventing sporadic congestion**. Even with tiered and time-of-day pricing, there can sometimes be congestion, either because planned extra network capacity has not yet been installed or because demand has risen temporarily and unpredictably. Congestion management in these circumstances can keep the service robust and does not need to depend on protocols or applications.[97]
- **Maintaining appropriate quality of service**. For uses such as web browsing, 20 Mb/s is not discernibly different from 40 Mb/s. Equally uses such as video streaming should avoid buffering pauses and broken frames but ensure good resolution and rapid response. Prioritising and throttling traffic could both improve the user experience and save capacity. However, it should be done only when there are clear differences between the quality of service requirements of classes of applications, not to discriminate for or against particular content providers.
- **Keeping users informed**. Users can shift easily from using one application to using another without appreciating the implications for network utilisation; for instance, they might shift from occasional

[97] Ways of achieving congestion management that do not depend on protocols or applications, such as that described in Bastien et al. (2010), have been developed partly in response to regulatory pressure. They preserve "net neutrality" (in one sense of the term) and do not facilitate discrimination for or against particular content providers.

two-participant voice calls to habitual several-participant video calls. They could be warned in useful ways when they approach the limits allowed in their pricing plans (by, for example, saying how many more minutes of their favoured applications would reach the limits). Doing this would mitigate bill shocks and moderate changes in network utilisation.

- **Making pricing comprehensible**. Users often do not have strong intuitions about what limits on download volumes, or even on downlink speeds, mean. They do, however, know which applications they would like to use. Limits on the use of particular applications, instead of on download volumes and downlink speeds, could allow more effective control of use both by an individual and in a household.
- **Recognising convergence**. Users will want to use different devices for the same application on different occasions. Their expectations of uniformity and quality of service will rise as superfast broadband spreads, but network capacity could be wasted by delivering content with quality high enough for their most demanding devices. This problem is most acute with video traffic, so a service provider might use compression to reduce the bandwidth requirements from those of a large television to those of a smart phone while maintaining a consistent impression for the user.
- **Providing special offers**. Special offers could be based on information about the customers (for their birthdays, say), the applications being used or the content being delivered. As an illustration, customers could receive the first fifteen minutes of a video stream free, and then be invited to view the rest with choices of levels of quality.

These tactics mainly envisage managing demand using pricing[98]. Some of them require techniques like deep packet inspection; in those cases they presume interaction between billing and deep packet inspection through functions for Policy and Charging Control (PCC) like those put forward for mobile networks.
Several of the tactics are relevant not only to satisfying existing users but also to attracting new users; for instance, special offers of free Internet access at certain times of day, together with the growth in Internet use for entertainment, could well appeal to the voluntary non-users of Section 2.5.

Ease of understanding can be increased by suitable presentation. For instance, the suitability of a pricing plan for particular times of day and classes of application could be presented in terms of "traffic lights" (with green for "always suitable", yellow for "sometimes suitable" and red for "never suitable", and with annotations to make the conditions of use clear). There have already been some suggestions (Technologia, 2011) and experiments (London Economics, 2011) about such styles of presentation.

Thus innovative adaptations of flat rate charging that are very clearly fair and easy to understand could prove attractive to existing and new users alike. As such they need advanced rating and billing systems, which are the "smart solutions" discussed further in the next chapter.

[98] However, pricing is used here not to limit availability but to distribute more equitably a resource (network capacity) that could otherwise appear to be unavailable, owing to congestion. In economic parlance, the resource is 'rivalrous': if somebody uses it then nobody else can.

5. TOWARDS THE BENEFITS: SMARTER THINKING

This chapter looks at superfast broadband mainly from the perspective of the service providers. The principal emphasis is on service features that can attract new users, stimulate new uses and produce new markets.

As discussed in Section 4.1, the major costs of superfast broadband are in physical infrastructure. Efforts to spread superfast broadband have focused on providing this infrastructure, and also (if to a lesser extent) on making it attractive for users to join and use the network. Between these two aspects lies a third: support systems for measuring, and accounting for, use, which are necessary for sensible network management and which underpin revenue flows and business models. These systems, which provide rating and billing functions, are collectively called 'smart solutions'; the term 'smart thinking' encompasses related ideas.

The chapter focuses on the benefits that could be obtained by smart thinking about serving users of broadband networks. It considers the following specific examples:

- **Getting more people online**. All commentators appear to agree that on grounds of both equity and efficiency, at least the option (if not the actuality) of broadband connectivity must be provided for every household in the UK as soon as practicable. There is much activity already to this end. We suggest an additional tool, which we refer to as 'personal Internet accounts' (explained in Section 5.1), that can be used in various ways to support people who are currently not online, and incentivise those who are connected to use their connections productively.
- **Making best use of network capacity**. Dynamic and interactive end-user tariffing could help to steer traffic into spare capacity in the access and core networks. Also, new levels of inter-carrier co-operation (such as radio network roaming) could greatly enhance the total capacity available to end-users. They might also help guaranteed service quality to be made available as a premium service.
- **Motivating more sharing**. Already many businesses provide "free" WiFi for their customers or visitors, and sometimes open this to the general public; private citizens sometimes do likewise. New schemes to detect, selectively permit, and motivate such facility sharing could boost willingness to provide it and lead to growth in wireless mesh networks, with both permanent and transient links. Similar schemes might also motivate certain forms of volunteer computing.
- **Improving micropayment systems**. Micropayment schemes could be made more widely applicable, more usable by customers, and more appealing to businesses. This is particularly important as they come to be used on smart phones for everyday transactions.
- **Extending the reach of smart solutions**. Some applications of machine-to-machine communications, such as smart grids, need to be accompanied by new or enhanced support systems. For this purpose they could use either the smart solutions of telecommunications (as well as the physical infrastructures) or their own new smart solutions, depending on how large they are.
- **Virtualising smart solutions**. Though the costs of physical infrastructures for superfast broadband are large, the benefits will accrue (at least in part) to businesses that serve niche markets or are small. To make the most of these benefits the businesses could use smart solutions offered by others.

5.1 Getting More People Online

Ensuring that all people in the UK can use the Internet will be necessary, as well as fair: pressures to reduce costs are leading to the removal of offline alternatives. Some people might need to use the Internet through proxies, such as carers, friends and relatives. However, overall the following non-users will need to be targeted:

- Those who choose to be offline, although they are not in financial difficulties or disabled.
- Those who willingly go online provided they receive adequate support (which may for example be financial, or involve the provision of specialised equipment, training or help).
- Those who are unable to take personal advantage of the Internet, for example because of severe intellectual impairment.

The improved user interfaces offered by smart phones, tablets and the latest Internet-capable televisions are already making Internet use easier and more appealing to many non-users. Another help could be new personal Internet accounts, involving smart solutions. Every citizen would have at least one such account, which could be held by an ISP of their choice or (if they made no choice) allocated to an ISP on their behalf. The access would not be tied to any specific device, but would enable its owner to log in at any hosting Internet-connected device.[99] Stored account information might conveniently be carried on a small USB device or machine-readable card. Access and usage would be debited from the account, charged at rates specific to the person and (possibly) application, and/or the account could be credited directly from outside. Account information could include preferred terminal settings, for example for people with sensory impairments. Applications of such accounts could include the following:

- **Shared terminals**. For example, several neighbours could pass a single wirelessly connected laptop around among themselves, with usage charged against their personal quotas. This might work well in some sheltered housing or residential institutions.
- **Internet visitors**. Anyone visiting (for example) a housebound disabled person, and carrying with them a smart phone or 3G laptop, might help the disabled person to access the Internet, or access it on his or her behalf, without cost to their own account (and, in the first case, with the possibility of maintaining the disabled person's privacy).
- **Incentivised use**. For people who have physical Internet access available but do not use it, or have an Internet-capable terminal that is not actually connected, the account could provide cut-price access, and using specific 'desirable' applications could build up virtual credit which could lead to rewards. This might apply, for example, to completing training courses, applying for jobs, or contributing to communal tasks.

[99] The scheme resembles the "Cloud Phone" of Movirtu (http://www.movirtu.com). This lets low income users in developing countries use different mobile phones, owned by other people, while having their own telephone numbers and voice mail boxes. It also has some kinship with schemes such as Boingo (http://www.boingo.com).

- **Marketing vehicles**. Personal accounts would be powerful tools for tempting the voluntarily unconnected online, with the potential for personalised special offers, short-term equipment rental and limited-commitment service deals.

Of course, these accounts are only one part of the tool kit. There will be a continuing need for inclusively designed equipment and services which are usable by people with a wide range of abilities, as well as special equipment and services for people with severe or unusual disabilities. Outreach, awareness-raising and training will all still be required, as noted elsewhere (Consumer Expert Group, 2009). But it is reasonable to suppose that such a development could contribute substantially to bringing forward a 100% connected UK, with all its associated savings and benefits.

5.2 Making Best Use of Network Capacity

Many online activities are already possible for people in most parts of the UK using existing Internet infrastructure. Email, web search, browsing and interaction, voice over IP, music and video download are all possible using basic broadband. The main current services that require higher speeds are those with significant video components, especially high definition video streaming. But there is considerable user dissatisfaction with basic broadband, and in particular with its variable service levels. Service providers' perceptions are summarised as follows:

> …Significant time and effort has been invested to optimise the quality of the consumer experience. Common elements of a good user experience, cited by interviewees, included a swift site launch, an uninterrupted browsing session (i.e. no page freezes or crashes), intuitive navigation around the site and consistent playout of any video content. Several interviewees commented that customers are increasingly intolerant of a poor experience ... Service providers prioritised different elements of the user experience. For content providers, consistent playout of video content was identified as a key priority; e-service providers proved to be more focused on in-site navigation, reflecting the type of customer interaction. (Value Partners, 2010)

The same report points out that some efforts are already made to optimise user experiences given their actual connections. For example, 'lite' versions of downloads may be offered (typically providing lower-resolution images faster), and adaptive bit-rate techniques are used to achieve continuous video viewing, albeit with lower quality.

On the other hand, much of today's commercial Internet content is designed to provide ever "richer" online experiences, and is built on the presumption that users have fast connections. A typical website may open with a short movie, with later pages offering 360° views and multimedia options. Often there is no way of jumping past introductory material to access later content. Users with relatively low bandwidth connections are likely to find these sites slow to load and frustrating to use. As digital storage costs have fallen, so too has the size of software packages risen, and along with them the size of the automatic updates that they often generate. Data download quotas can be used up easily without the user realising what is happening. Effectively, content generators are taking advantage of "free" capacity which allows them to reach some users (and create hunger in others), without regard for the load placed on networks.

Data traffic might expand to fill the capacity available to it; just as road traffic does. Three questions arise:

- How does one decide what broadband speed to provide to everyone in the UK? This has been discussed at length; the result for the time being is the 2 Mb/s Universal Service Commitment (USC) originated under the last government and confirmed as a goal for 2015 by the current government.
- How does one decide what broadband speeds to provide as upgrades beyond the universally available speed? This seems to be settled more on grounds of immediate cost than future-proofing, as indicated in Section 3.4.
- How does one make most effective and efficient use of the connections and capacity that actually exist at any given time? This has received less public attention, with the issue largely left to the industry to resolve as best it can.

The third question could usefully receive more exposure and public guidance. Measures may be needed to improve and assure the Internet experience of those households with relatively slow connections. For example:

- There could be a standard practice of offering different versions of content, optimised for different types of devices. For mobile devices a primitive realisation of this is provided by the .mobi top-level domain, at the cost of violating the intended device-independence of the Internet. A preferable realisation is one in which users have the option to input their preferences, either case-by-case or on a more lasting basis, and are charged accordingly when the support systems determine that their preferences are compatible with their devices.
- Users could be offered differently priced options, for example, for the speed and timing of large downloads. Suitable price differentials could help to move traffic from peak to off-peak periods, thereby reducing peak congestion and improving user experiences. Networks could, if necessary, react dynamically to conditions in real time for purposes of congestion management.[100] Charges could be varied according to the nature of the application (so, for example, priority would be given to voice and video) through suitable interactions between networks and rating and billing systems.
- Additional capacity could be made available by combining the resources of separate wireless networks. National roaming between networks in remote areas has been proposed for the UK (and used elsewhere) as a way to extend mobile network coverage.[101] It could equally be offered (perhaps for a premium) as a way to supplement capacity anywhere.

[100] Such dynamic and interactive end-user pricing is certainly feasible, though not yet common, even for telephony. Since 2008 MTN in South Africa has offered for its mobile service its MTN Zone pricing plan (http://www.mtn.co.za/FindaPlan/PayAsYouGo/Pages/MTNZone.aspx). There are up to 95% discounts on call prices, depending on current local base station loads. Subscribers are notified of current rates by cell broadcast from the base station.

[101] CMA (2011) discusses the cases of France and the US, especially in relation to LTE. A fairly widespread approach is to require or encourage an existing service provider to provide commercial terms so that a new service provider can offer national roaming to its customers.

A collaborative industry approach, exploiting the best available network management and customer interface technologies, which would be likely to include smart solutions, could be the way forward. Service providers noted a trade-off between customer reach and availability of content and features as follows:

> … a simple clear presentation of information accessible over multiple devices and the widest network footprint was more important than offering richer content. For public sector service providers, reach was particularly important reflecting their greater emphasis on universality of access. (Value Partners, 2010)

With better management, the stress could be less on a trade-off and more on providing a good experience for all users.

5.3 Motivating More Sharing

Broadband provision has already often been achieved with the help of community involvement, especially in poorly served rural areas, and this looks set to increase in future with the encouragement of organisations like the Independent Networks Cooperative Association (http://www.inca.coop). Local contributions have included, for example, stimulating and collecting commitments to subscribe once service arrives, group commissioning of a cable connection, physical help with installation (for example, trenching across farmland), and allowing local connection through private facilities, usually wireless (currently WiFi or WiMax). Important factors in the success of community networks are said to be distinctive local services and the feeling of "belonging". But such community effort calls for dedicated individuals with certain skills and resources, who do not exist or come forward everywhere one might wish.

An advantage of radio technologies is that inherently they can be shared: unlike cable, they are 'just there' and in principle, with suitable security permission, usable anywhere within a coverage area. Co-operative communication based on mesh networks (where signals are relayed between overlapping areas of radio coverage) could usefully extend rural coverage, from the end of a cable or even from a satellite terminal, to outlying premises. They could even seek out, and include relays from, moving vehicles, to help to maintain radio coverage along remote roads or paths.

This sort of development may come about purely through community spirit; but again, unlike (say) Wikipedia, it depends on the right people being available when and where they are needed. Ways to encourage such sharing might be a useful extra tool. Again, transfers of credits to and from personal Internet accounts (possibly through intermediaries) could provide incentives. There might be an analogy with feed-in electricity tariffs, which have stimulated the adoption of small-scale renewable electricity generation, but there are also differences: to a large extent community networks and co-operative communication involve people who know each other, while feeding electricity into the national grid is working with an impersonal organisation.

An incentive scheme for encouraging sharing might apply to co-operative computing (known as "volunteer computing") as well as to co-operative communication. Volunteer computing is a form of participation in a community made possible by the internet. Volunteers provide background processing on their computers for

use in worthwhile distributed computing applications, such as climate change prediction (http://climateprediction.net) and protein folding simulation (http://folding.stanford.edu), often built on the Berkeley Open Interface for Network Computing (http://boinc.berkeley.edu). Measures of the work done are already used to provide non-monetary incentives to volunteers, but they are usually limited to counting processing operations and could be extended to counting relevant content packets transferred across the Internet, with transfers of credits where appropriate.

Some web sites have monetary incentives to encourage users to share content by uploading it. Until its effective demise, Knol, which was once regarded as a potential competitor to Wikipedia, offered the incentive of giving users pay-per-click revenues from advertisements alongside their contributions. On the whole experiments with incentives for encouraging sharing of content have not had happy results.

In fact an incentive scheme for volunteer activities must be designed very carefully, if it is to increase, instead of decrease, motivation and performance.[102] Some possible lessons are provided by games, which have amassed over the years many techniques for keeping people interested in both the activities and the outcomes.[103] Of course, the motivations for participating in volunteer activities are not those for playing games, and some techniques common in games (such as requiring "enough" participation if credit is not to be lost) could be counterproductive in other contexts.[104]

5.4 Improving Micropayment Systems

Various micropayment systems already exist which help in online and other remote transactions. The systems are typically associated with different devices (such as personal computers, mobile handsets, games consoles, e-readers or interactive televisions). The transactions are often purchases of online content, for entertainment or information, but they are sometimes purchases of goods that are delivered in physical form

[102] Frey et al. (2001) surveys many experiences and experiments in which incentives decrease motivation and performance. Econometric studies include those of blood donation (in which payments for donations can reduce the number of donations), company management (in which direct personal supervision by a chief executive officer can be less effective than "arms length" reporting by a subsidiary), and volunteer work (in which small monetary rewards can reduce the hours worked). There are also laboratory experiments and field surveys with analogous results. Bénabou et al. (2006) provides one mathematical model of the phenomenon, drawing on the distinctions between external (typically monetary) incentives, "warm glows" and reputations as motivations; these can counteract each other because, for example, external incentives can reduce the enhancement of reputations by casting doubt on what the "real" motivations are.

[103] The use of these techniques (or "game mechanics") for changing behaviour in other areas is, unfortunately, sometimes called 'gamification'. The techniques include, for example, using virtual currencies (as even a loyalty card scheme does), allowing small steps, welcoming skill improvements, and comparing levels of achievement (both within and between communities).

[104] Game designs can have unexpected consequences. For instance, a suggestions scheme in Lloyds Bank, in which participants could use the virtual currency to buy and sell virtual shares in "listed" suggestions, led to hyperinflation and insider trading (which in turn encouraged participation in the teams that originated and developed the most valuable suggestions) (Gardner, 2008).

or of tokens that can be redeemed for goods or services (such as tickets for events or journeys). The micropayments might be made through prepaid or postpaid telecommunications bills, to credit or debit cards, or to accounts special to applications. The accounts special to applications often contain virtual currencies that are bought using real currencies and that can be used to buy virtual goods in virtual worlds. The revenues of large social games providers come almost entirely from sales of virtual goods in virtual currencies.

A report (Analysys Mason, 2010b), for the premium rate phone service regulator PhonepayPlus, highlighted perceived and potential regulatory problems and deficiencies from a user viewpoint. These included:

- Consumer rights and protection that vary between micropayment systems.
- The possibility of making unintended purchases.
- The difficulty of obtaining redress for unintended or unsatisfactory purchases.
- The lack of transparency in the prices to be charged for some services.
- The lack of clarity in the rates payable when buying or selling virtual currencies; converting between virtual currencies and real currencies can even require intermediate conversions into other virtual currencies, and each such conversion can have a poor rate of exchange.

There is an opening here for trusted micropayment agents, who might be, for example, Internet service providers. These agents would offer an integrated payment interface such that, by using any connected device, a consumer could spend sums held in electronic "purses". Electronic purses accessed through ubiquitous devices have several advantages. In particular:

- The agent could work towards unified and improved presentation and terms and conditions for the purses; for instance, they might require that any virtual currencies that they supported would offer consistent conversion rates and "cooling off" periods for purchases. This should enhance consumer comfort and confidence in making the relevant transactions, reduce the chances of making unintended purchases, and more broadly stimulate Internet use.
- The agent could make the integrated payment interface send transaction detail records to a rating and billing system. This system could be that of an Internet service provider, for example, that would thereby let micropayments be made through telecommunications accounts.[105] Consumers are said to regard this as the most trusted way of making micropayments, but current implementations identify purchasers only by phone numbers and require phone calls or text messages[106].

[105] An alternative way of extending to Internet services the facility of charging micropayments to telecommunications accounts is to make networks interact with rating and billing systems: deep packet inspection engines would identify the items purchased and rating and billing systems would charge for them. However, doing this would be unnecessarily laborious and, more significantly, could raise acute problems of confidentiality, as all the packets would need to be inspected.

[106] There are various such micropayment systems intended mainly for mobile handsets, among them being implementations of Payforit (http://www.payforituk.com). Their rules about presentation and content can help in making clear to potential purchasers the prices, terms and conditions, and details of the items to be purchased.

- A consumer could have several separate purses. This would cater to the phenomenon, borne out in experiments, in which people allocate their prospective expenditures to separate "mental accounts" that they are willing to use only for very particular purposes.[107]
- A consumer could hold different currencies in different purses. This could simplify and clarify conversions between virtual currencies and real currencies, which the agent could perform at very low cost.
- A business might have advanced charging capabilities, such as basing special offers on the revealed preferences, profiles and behaviours of customers. These offers would, of course, require informed consent from the customers.

Micropayments could then also serve for the contactless purchasing of goods that have bar codes, Quick Response (QR) codes or near-field Radio Frequency IDentification (RFID) tags: the purchasers would use suitably equipped mobile handsets to identify and charge for the goods.

5.5 Extending the Reach of Smart Solutions

Some companies have used machine-to-machine communications for several years, but recently new applications have been emerging as the costs of access and the need for human intervention in operations, maintenance and control decrease. Compound annual growth rates of 258% until 2015 have been projected for machine-to-machine Internet traffic (Cisco, 2011).[108] Perhaps more conservatively, compound annual growth rates of 25% for the same period have been projected for machine-to-machine devices on mobile networks, driven to a large degree by smart grids (Pyramid, 2011).

Remote surveillance and sensing, monitoring fixed locations for security, road conditions and environment quality, are among the well-known applications of machine-to-machine communications using fixed networks. However, applications using mobile networks to build components of intelligent transport systems are coming to the fore. Among them are the following:

- **Asset tracking**. Assets in transit, ranging from packages with RFID tags to vehicles, can be tracked. Fleet management is already well established. London busses, for example, send information about their locations and speeds roughly every thirty seconds to control centres that can regulate the intervals between busses and distribute "next bus" information through a web site (http://countdown.tfl.gov.uk), in response to text messages, and to bus stops.
- **Automatic emergency calling**. In the EU intelligent transport action plan (EC, 2011a) the first application of machine-to-machine communications is to emergency calls providing detailed location information. These are to be triggered automatically by sensors or manually by witnesses in vehicles

[107] Thaler (1999) gives many examples of how mental accounting influences decisions.
[108] This projection probably regards anything other than a computer, a television, a tablet or a phone as a machine-to-machine device. In that case e-readers, digital picture frames and digital advertising displays, for example, would be machine-to-machine devices.

after serious accidents. To allay privacy concerns, the system does not send any signals until it is triggered.

- **Vehicle monitoring and servicing**. Car makers are likely to incorporate automatic emergency calling in broader systems in vehicles using machine-to-machine communications. Such systems could support routine maintenance and provide location-based services. For instance, faults could be forestalled, detected or diagnosed remotely, or available hotel rooms could be identified and reserved through automatic navigation aids. Various insurance companies and governments are considering "pay as you drive" systems for insurance and road pricing: vehicles would send messages when they started and stopped, and possibly during journeys (to describe the driving style), and drivers would be billed accordingly. Again privacy problems would arise (especially as data retention laws in the EU require mobile service providers to keep the location information in messages for some months).

Only some of these applications would benefit immediately from the higher speeds or greater frequencies of communication made possible by superfast broadband access, though several need high capacity near their control centres. The same is likely to hold for health care: initial applications in the home are likely to generate small files with results from simple tests (of blood sugar levels, blood pressure and so on) not large files such as scan images. Subsequent applications might well create further requirements for superfast broadband access; remote surveillance of bus interiors exemplifies how requirements could develop by combining the strengths of existing applications.

All this is also true for initial applications related to appliance monitoring and control (in smart grids and smart buildings). Nonetheless, smart grids deserve to be considered further, because they not only use machine-to-machine communications, but because they need capabilities that they could either buy from existing communications service providers or build for themselves. In particular:

- Power Line Communication (PLC) could be used between the distribution substations and the premises to carry at least the signals needed for smart metering (and arguably broadband Internet access, too). This is not widely advocated in the UK.[109] Adaptors would be needed in the substations if the signals were also to be carried over the higher upstream voltages using PLC. In practice fibre or wireless would be used to go further upstream.[110]
- Rating and billing systems for smart grids could be developed independently of those for telecommunications, though they will come to share many of the same characteristics. Especially

[109] However, PLC has been deployed in many premises in the UK, with at least 1.8 million devices, despite some questions about the interference generated (Hansard, 2011). Also, PLC has been deployed in distribution networks in Italy (to at least 30 million premises) and elsewhere (Rogai, 2007). By contrast, in Switzerland several electricity companies have agreements whereby they or Swisscom would lay fibre to the premises. These agreements, however, have been determined to be anti-competitive (Widmer, 2011).

[110] There are about 420,000 distribution substations in the UK, so each serves over 60 premises on average. By comparison, a BT cabinet serves over 300 premises on average. Hence if broadband Internet access were provided using PLC, with fibre used to go upstream from the substations, the costs for fibre would be well above those for FTTC. In addition the costs of multiplexors in substations would be likely to be higher than those of multiplexors with VDSL modem, because the production volumes would be likely to be smaller.

given the recent stress on developing competition, there are likely to be innovative pricing packages; for instance, they might aim to move traffic from peak to off-peak moments to reduce demand surges during breaks in popular television programmes.[111] There will be enormous numbers of meter readings to be aggregated, processed, and stored, and consumers will monitor their consumption in real time.[112]

A particularly relevant application of smart grids, that combines many features of machine-to-machine communications, is electric vehicle charging. Drivers will need to find the nearest charging points (with their prices), authorise themselves to use charging points, and pay using prepaid or postpaid accounts; consequently vehicles and charging points will need to communicate with the central support services for rating and billing. Drivers would like to use charging points provided by different charging point service providers (if necessary paying them from separate "purses", in the sense of Section 5.4), and charging point service providers might like to have different electricity suppliers at different charging points. The prices would vary according to demand (which could surge during rush hours), the pricing plans of the drivers and any special offers. Revenue and cost settlement would present a complex multi-party problem, rather like that in mobile networks with roaming. When the demands are coupled with those of smart meters, the problem is likely to require as much expertise as mobile services. Small electricity providers and charging point service providers are likely to buy the expertise from communications service providers; large ones might choose to build support systems of their own.

5.6 Virtualising Smart Solutions

Mobile Virtual Network Operators (MVNOs) have long been recognised as serving niche markets (or at least markets addressed by specific marketing) in telecommunications; one niche where they might be expected to position themselves now is machine-to-machine communications specialised to the requirements of particular industries. As such they could obviously use smart solutions, which would be owned by them, hosted for them (by, or on behalf of, the network provider that they depended on), or partly owned and partly hosted.

Broadband increases the opportunities in other industries for serving niche markets: an online retailer can seek a widespread market for a narrow range of goods or services. Many such retailers will be situated in

[111] There is an analogy here between deep packet inspection engines and smart meters: both could provide information to the billing systems and respond to user preferences (whether online or preconfigured) mediated through the rating and billing systems. However, typically in responding to user preferences a deep packet inspection engine would merely broaden or narrow gates on the data flows, while a smart meter might need to co-ordinate its operations with the smart appliances that it metered.

[112] Even here non-monetary motivations for improvement could be important. For instance, "To boost customer engagement, the GreenPocket social metering app helps consumers share their carbon footprint in a competitive and entertaining way on Facebook. Even without constant interaction, push notifications inform consumers of how well they are doing compared to their friends (e.g. in weekly energy efficiency contests) and about lots of other positive developments related to their energy consumption behavior." (GreenPocket, 2011).

rural and remote areas, where they will be particularly dependent on initiatives to ensure ubiquitous deployment of basic or fast broadband. Others will be situated in urban areas, where they can expect to avail themselves of superfast broadband when displaying their wares, but where they will need to remember that some potential customers might not be so fortunate (as discussed in Section 5.2). Either way, they will increasingly rely on communication services and will therefore wish to have more tailored smart solutions.

In fact smart solutions are available for other industries besides telecommunications, though most uses so far have been by large businesses, which can host the smart solutions in private clouds in their own networks. However, with broadband, service providers could host smart solutions intended for shared use by small businesses, even those located in rural and remote areas. Such smart solutions would probably not use public clouds, open to all: they would probably use what might be called "virtual private clouds", which would be shared between subscribers but would offer the guarantees on security, availability and responsiveness that, for example, rating and billing in real time require.

Becoming a trusted micropayment agent of the sort described in Section 5.4 is one way in which a service provider could make a smart solution available for shared use by small businesses. A service provider might choose to start a hosted smart solution in this way and then broaden the scope to cover other sorts of transaction.

Customers are likely to prefer those businesses that use smart solutions because such businesses can be more responsive and informative than others. Consequently there will be "network effects" in the form of growing traffic between the customers and the businesses, as well as between the businesses and the service providers that host the smart solutions. There will be similar effects as the businesses themselves join in virtual communities, as discussed in Section 2.1, to enhance innovation and improve supply chains.

In summary, the investment risk on physical infrastructure might be much greater in rural and remote areas than in urban areas, but the returns to service providers from offering services using the infrastructure in those areas could be higher per connection than in urban areas, as demand from businesses and their customers would otherwise be left untapped. Thus the opportunities offered to service providers by broadband deployment and smart solutions should extend beyond telecommunications.

PART II. AN INTERDISCIPLINARY VIEW OF SUPERFAST BROADBAND, COMMUNITY CURRENCIES AND SMART SOLUTIONS

Paolo Dini

6. COMMUNITY CURRENCIES

With an increase in bandwidth come more opportunities to customise and manage the offer to the consumer while simultaneously monetising assets for operators through the packaging of new services. For example, charging can depend in real time on consumer usage patterns, bandwidth requirements, or network availability. On longer time-scales, a market analysis engine can propose different service packages based on demographics, lifetime choices, or lifetime values. The data can be obtained through a combination of passive profiling and active interactions with the consumer. These are examples of an intelligent technology layer, collectively referred to here as 'smart solutions', that is becoming increasingly important in the online service economy. Smart solutions include, at their core, rating and billing technology that supports the quantification of value and therefore the monetisation of the services offered.

Smart solutions can be understood as "impedance-matching devices" that optimise the match between the supply and the demand of online services whilst simultaneously abstracting the relevant information flows into units of currency and providing credit and debit positions transparently to providers and consumers alike. The result is a greater efficiency of the online service market seen as a complex, real-time global system which, through multiple Internet Protocol (IP)-enabled technologies, connects millions of users to thousands of service providers, to hundreds of networks (the Internet), and to tens of operators. We could say, therefore, that smart solutions are able to expand the online service market by making better use of the time and of the information available. If we are to maintain this property as superfast broadband is introduced, then we are looking for an expansion of the market that benefits all the stakeholders. This is constructive and positive thinking, but given the current economic climate it is easier said than done. In this paper we therefore adopt a more cautious outlook, for instance through the discussion of possible benefits and returns in Sections 2.6 and 4.3. In this part of the paper the focus is more specifically on how to monetise the value generated by the social dimension.

As discussed in Chapter 5, we can adopt several strategies to extend the user base for broadband, which ought to lead to an expansion of the market for content and services. A claim investigated in this and the following two chapters is whether a similar effect may be achievable by 1) extending the definition of economy to include things that are currently regarded as belonging more to the social dimension, and 2) using this different viewpoint to explain and perhaps increase the monetisation of social value through the use of community currencies (CCs). I begin with the latter, in this chapter, because CCs offer a practical example and empirical basis that may make it easier to follow the more academic arguments of Chapter 7. Thus, this chapter explores the use of CCs as a different way to quantify, and indeed monetise, a part of the social value we normally find difficult to relate to market dynamics. In Chapter 7 I discuss how the economic anthropology perspective can explain the emerging and growing integration of market-based and commons-based modes of production, thereby providing a possible rationale also for the use of CCs in the context of superfast broadband and smart solutions. In Chapter 8 I then discuss two integration examples.

Thus, this and the subsequent two chapters offer an analysis of the problem that combines different disciplinary points of view. The objective is to develop a framework through which untapped social value – for example what has not already been harnessed for advertising – can be connected to the revenue flows of the online service market. The research question is whether community currencies (CCs) and smart solutions, acting together, could *potentially* provide this bridge. I emphasise 'potentially' because the jury on CCs is still out. They have been around for a long time and in some cases they have been effective in terms of stimulating economic growth at the local level, but in other cases they have not. Further, their implementation and management involve a very complex integration of social, economic, and governance processes that are far from trivial even when taken individually – and for this reason they remain very interesting theoretically.

6.1 Questioning Assumptions

The view explored in this and the next two chapters attempts to balance utilitarian/functionalist thinking with some critical analysis of the possibilities. The starting point is to put in question some of the assumptions we normally take for granted; for example,

- Is money as we know it the best instrument for supporting economic growth? Can we define money in social as well as in economic terms?
- What is the relationship between social value and economic value? How do we define them?

CCs can be seen as part of a "hands-on" and empirical methodology to study these kinds of questions. Although local currencies have existed since time immemorial in all human cultures, the concept of and motivation for the modern CC phenomenon can be traced to Robert Owen in England in the 1820s (Schroeder et al., 2011; Polanyi, 2001[1944]). In describing Owenism, Polanyi says:

> Cooperative societies were founded, mainly engaged in retail to their members. These were not, of course, regular consumers' cooperatives, but rather stores backed by enthusiasts determined to devote the profits of the venture to the furtherance of Owenite plans, preferably to the establishment of Villages of Cooperation. … At the heart of the Exchange or Bazaar there was reliance on the complementary nature of the crafts; by providing for one another's needs, artisans would emancipate themselves, it was thought, from the ups and downs of the market; this was, later, accompanied by the use of labor notes which had a considerable circulation. Such a device might seem fantastic today [i.e. in 1944]; but in Owen's time the character not only of wage labor, but also of banknotes, was still unexplored. (Polanyi, 2001[1944]: 176)

The socialist overtones that transpire from this description are not coincidental. As Polanyi explains, Owenism can be seen as the 'fount of modern socialism' (Polanyi, 2001[1944]: 178), and '… practically, it was the beginning of the modern trade union movement' (Polanyi, 2001[1944]: 176).[113]

[113] Robert Owen was born in 1771, 47 years before Karl Marx.

Another important reference for many CC initiatives and commentators is Silvio Gesell's concept of perishable money, or 'demurrage', by which money should deteriorate in a manner similar to the commodities it is used to buy (Gesell, 1934[1906]). Such an effect, according to Gesell, would induce anyone who had money to spend it as quickly as possible, before it lost value. Some form of this concept has been implemented in some CC systems, for instance the WIR (to be discussed more fully below) in the initial period 1934-1948 (Studer, 1998). Of course, inflation has a similar effect, although usually not by design.

Another reason CCs are theoretically interesting is that a similar concept was proposed by none other than Friedrich Hayek (1976), one of the inspirational figures for Thatcherism, Reaganism, and neoliberalism in general, in an attempt to address the then vexing problem of inflation. As an initial and more concrete step Hayek proposed that

> the countries of the Common Market … mutually bind themselves by formal treaty not to place any obstacles in the way of the free dealing throughout their territories in one another's currencies (including gold coins) or of a similar free exercise of the banking business by any institution legally established in any of their territories. (Hayek, 1976: 23)

As a generalisation of this idea and a 'more far-reaching scheme',

> [i]f we are to contemplate abolishing the exclusive use within each national territory of a single national currency issued by the government, and to admit on equal footing the currencies issued by other governments, the question at once arises whether it would not be equally desirable to do away altogether with the monopoly of government supplying money and to allow private enterprise to supply the public with other media of exchange it may prefer. (Hayek, 1976: 26)

Here is a "market solution" if ever there was one. As will be discussed in Chapter 7, the market has much to gain from a closer integration with the social dimension. Further, currencies serve important social functions in addition to the economic. For example, the establishment of the Euro (which, ironically, Hayek warned against as a move in the wrong direction) can be seen as another element of the drive towards creating a united Europe, quite apart from the economic implications. Although Hayek's proposal seems interesting and provocative from a technical and structural point of view, it seems risky to rely on competition alone in the case of multiple "private-sector" currencies. As will be discussed later in the chapter, in fact, such a purely market-based solution arguably would require a higher and more uniform level of democratic maturity across Europe than can be observed currently. For example, especially in the presence of the current sovereign debt crisis, the political, social and cultural processes of unification appear to lag the establishment of the Euro by a few decades, at least. In other words, whether or not the establishment of the Euro was a good idea on technical grounds, it seems that the economic and democratic culture of Europe is not even ready for a single currency, let alone a free market of anybody's competing currencies, suggesting that Hayek's proposal might have been made long before its time.

Be that as it may, from these references it seems that there is an intriguing "structural" appeal in the concept of multiple currencies that transcends political viewpoints. At the same time, I side with Polanyi in arguing that the political and economic dimensions of society should be closely integrated. By this I do not mean to

advocate, necessarily, top-down intervention of the government in the market. Rather, the point already stated in the introduction that the market is much less "free" than is claimed by some could be extended into a more general postulate that the more "free" a market is the more democratically mature must its participants be, if the objective is to achieve sustainable economic growth. Various institutional forms could then be seen as meso-scale "buffers" between the ideal of the globalising free market and the individual. Whether such institutions (should) safeguard the cultural and humane dimensions of society, or not, then becomes a normative question that can be addressed through the political process. In any case, a very interesting property of CCs in this regard is that without a suitable accountability and governance framework they simply do not work. Hence, from the point of view of social science they could be seen as useful "laboratories for institutional learning" that enable some level of experimentation of new ideas in a relatively protected environment.

Thus, this and the following two chapters explore the potential relevance of CCs, with an eye to their application in an online economy mediated by superfast broadband and smart solutions, with two specific longer-term research objectives in mind:

1. A study of the structural effects of different currencies and their possible relevance to economic dynamics, in the tradition of "value-free", objectivist, rationalist, and system-oriented scientific enquiry. This approach is more focused on relatively abstract global system properties at the expense of the role and perceptions of the individual.
2. What kind of governance framework can provide a level of institutional stability for CC systems that can enable them to scale up to levels of greater microeconomic, if not macroeconomic, relevance? This approach follows a political economy tradition in which an analysis of individual interests takes precedence over system understandings. At the same time, such an analysis of interests can benefit from an analysis of the underlying value system and, therefore, from an integration with the economic anthropology viewpoint.

In this relatively short paper I can only begin to outline such difficult research questions, hopefully informing the superfast broadband debate in useful ways. In the next section I provide a quick summary of some of the basic concepts and types of CCs, as a backdrop to a more in-depth discussion of the LETS and WIR systems. Although the WIR predates LETS, the latter is slightly easier to understand and for this reason it is discussed first.

6.2 CC Basics

The number of references on CCs is very large and growing. Their potentially important role in the current economic/debt/credit crisis is acknowledged by a range of recent publications (for example, *The Economist*, 2011; Boyle, 2011). As discussed in Breitstein and Dini (2011), CCs are local currencies that complement a national currency, usually with the intent to stimulate a local economy, particularly in tough economic times.

Accordingly, in response to the current recession, more CCs have arisen in the United States (Kadet, 2010). This highlights the ability of socially constructed concepts and practices to provide solutions to economic problems, a phenomenon that is more visible at local level.[114] CCs can be designed to fit the needs and requirements of specific communities. Thus, the Linden Dollar in Second Life has very different characteristics from the Ithaca Hours currency used in Ithaca, NY. Although an exchange rate (fixed or floating) between a CC and the national currency has been set up in many cases, the dependence of the CC on a local and socially embedded dimension implies that it is not suitable for long-range, impersonal transactions. More to the point, outside the community within which it was defined a CC has no meaning and no value. Because remuneration in a CC is taxable, its adoption requires a system of accounting that, in turn, requires high levels of transparency, accountability and trust in the community. Most, although not all, CCs do not accrue any interest (the Swiss WIR being a notable exception[115]). Therefore, their role as a medium of economic exchange with no intrinsic value is visible to everyone: the individual derives a greater utility from spending his/her savings in the local CC than from holding on to it.

I am speaking about 'economic exchange' and 'utility', so what is so different from the market? A possible answer is that CCs tend to mediate *use value* rather than *exchange value*. As discussed by Schraven (2000), from an economics point of view money has three main functions: unit of account, store of value, and medium of exchange. CCs that do not accrue interest (the majority) can be seen as a form of money for which the store of value function is minimised, leaving the other two functions more or less the same. The store of value function is still present, but an important consequence of the absence of interest is that there is a smaller incentive to commodify CCs *themselves*. In addition, due to their geographically limited validity, they tend to mediate small-scale exchanges. The local CC is used to pay someone who walks my dog or mows my lawn, not to buy the latest sports car. It can also be used to purchase goods and services from local businesses. The usual model is for the goods or services to be sold for a combination of national and CC, the exact proportion being variable and usually up to the local business or retailer to decide. Normally, participating businesses tend to be local businesses trading in basic goods rather than national chains or retailers of expensive goods, but this is by no means a fixed rule.

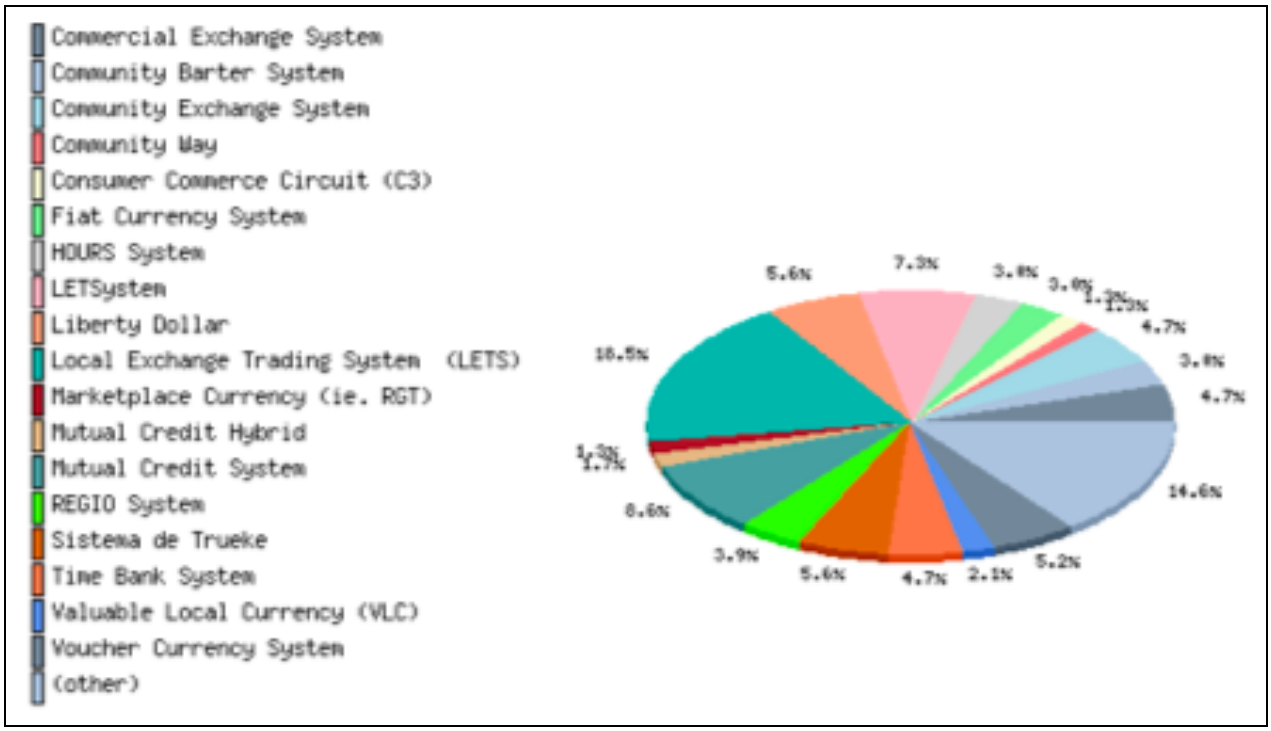
These properties taken together could be taken to support the claim that CCs tend to mediate use value rather than exchange value. However, it is fairly well recognised in the literature that 'The membership … does not correspond even closely to the average population and transactions are often not economically but ideologically motivated' (Schraven, 2000). In other words, the apparent lack of market speculation and

[114] "To say of something that it is socially constructed is to emphasize its dependence on contingent aspects of our social selves. It is to say: This thing could not have existed had we not built it; and we need not have built it at all, at least not in its present form. Had we been a different kind of society, had we had different needs, values, or interests, we might well have built a different kind of thing, or built this one differently. The inevitable contrast is with a naturally existing object, something that exists independently of us and which we did not have a hand in shaping. There are certainly many things, and facts about them, that are socially constructed in the sense specified by this core idea: money, citizenship and newspapers, for example. None of these things could have existed without society; and each of them could have been constructed differently had we so chosen." (Boghossian, 2001)

[115] See http://www.wir.ch (only in German, French and Italian). See http://projects.exeter.ac.uk/RDavies/arian/wir.html for a short summary of the WIR and the evolution that led to the adoption of interest in 1952.

profit-seeking in the great majority of CC implementations could be a reflection more of self-selected behaviour by the members on ideological grounds than of the structural properties of the medium itself. Therefore, such a conclusion seems premature, although worth a second look once we have developed the concepts a bit further.

In terms of turnover, the economic impact of CCs is extremely small when compared with any country's GDP. We can get a rough idea of what it might be by extrapolating from the data contained in the Complementary Currencies Resource Center (CCRC) website,[116] a database that publishes only data that has been voluntarily provided by CC initiatives around the world that have registered with it. Currently there are only 224 CC members registered (called 'Local Exchange Systems' on this website), spanning about 15 or 20 types of CC, as shown in Figure 6.1. As stated by the curator of the database, an approximate estimate for the total number of implementations is 'at least 1,500 systems, with an estimated maximum of 3,500 at present' (DeMeulenaere, 2011).



Source: CCRC, www.complementarycurrency.org

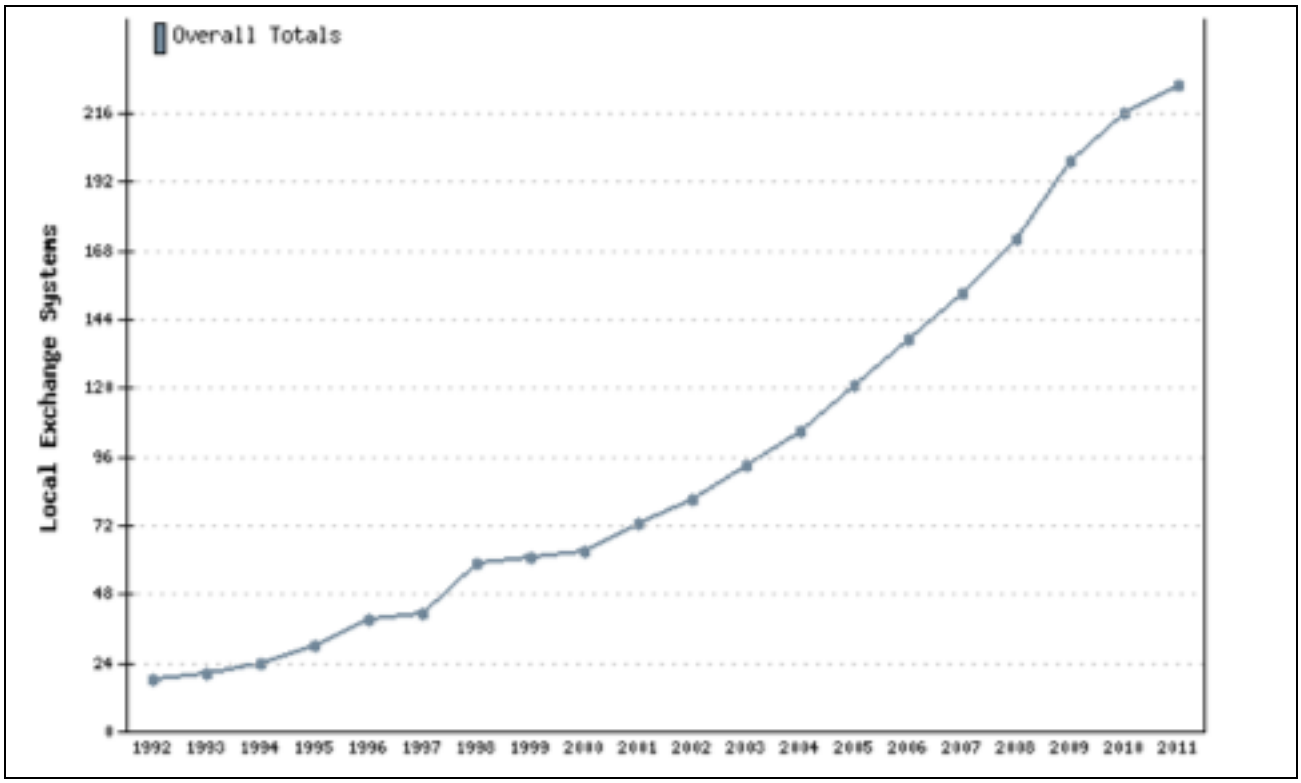
Figure 6.1: Different types of CC and relative distribution of implementations of each

The growth of CC registrations to the database over the past 20 years is shown in Figure 6.2. As the total volume of trade for the 224 registered systems in 2010 is approximately US$107m,[117] a linear extrapolation

[116] http://www.complementarycurrency.org/ccDatabase/les_public.html

[117] DeMeulenaere (2011) warns that this number is only approximate because not every CC system contributing to the database updates its figures regularly.

for 1500 systems would be about US$700m. This is only a small fraction, for example, of the UK GDP: £440m/£1.5tr = 0.3%. The contribution of the UK CC implementations would be even smaller of course. Thus, it would appear that in their current form CC systems are not likely to be an important part of any country's overall economy.



Source: CCRC, www.complementarycurrency.org

Figure 6.2: Growth of CC systems worldwide since 1992 (indicative only, see text)

The size of the WIR system is also small in GDP terms, but is in a different class from all other CCs. The WIR is not one of the systems registered with the CCRC database, so it is not included in the numbers above. Data on WIR is not easy to find and it is usually not in English. Table 6.1 gives a sense of WIR turnover over the past 50 years and Figure 6.3 shows a graph of the ratio of WIR turnover to Swiss GDP. The numbers are still small, relative to the national economy of an average European country, but larger than all the other CC systems combined. This fact suggests that the WIR system may have microeconomic relevance, especially if multiple WIR-like systems were to be adopted in different countries, even if its macroeconomic impact might not be very significant. Further, since it is implemented electronically, it is mostly subscribed to by small and medium-sized enterprises (SMEs), and it has evolved into a significant banking business in its own right, it seems of potential relevance to strengthen the economies of outlying areas of the UK, especially if used in conjunction with superfast broadband and smart solutions. Before discussing WIR in more depth, I first describe LETS.

Table 6.1: Comparison of WIR turnover and Swiss GDP[118]			
Year	***WIR Turnover (CHWb)***	***Swiss GDP (CHFb)[119]***	***WIR/CHF GDP (%)***
1964[120]	0.1	15	0.67
1980	0.25	110	0.23
1991	2.0	240	0.83
1993[121]	2.5	250	1.00
1997[122]	2.1	280	0.75
2005	3.0	370	0.81
2007[123]	3.2	420	0.76

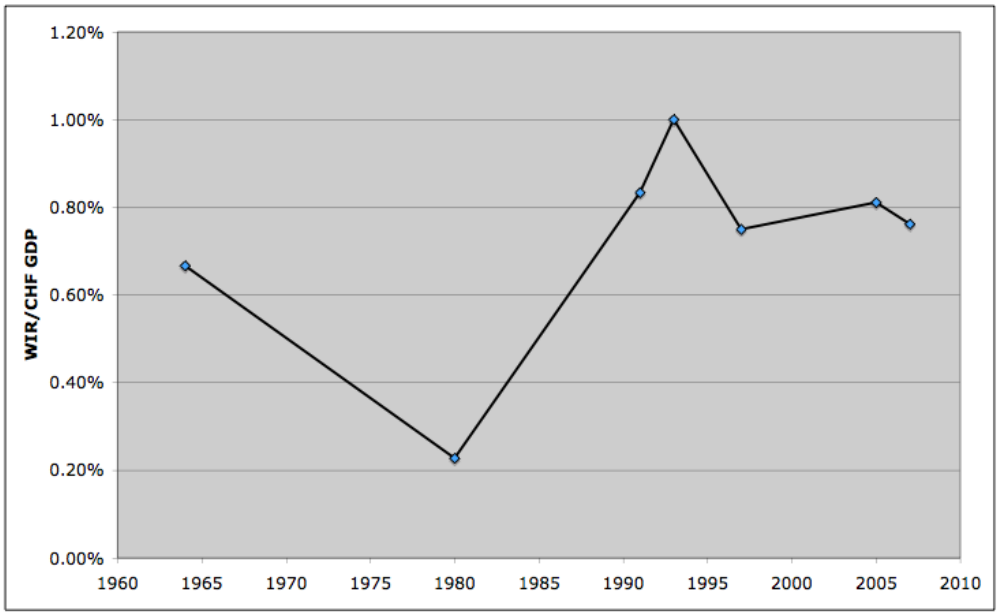


Figure 6.3: WIR turnover expressed as percent of Swiss GDP

6.3 Local Exchange Trading System (LETS)

Following somewhat different criteria from the CCRC database, Schroeder et al. (2011) mention 32 different types of CCs, for a total of 685 CC implementations worldwide, of which LETS systems represent 22%. Longhurst and Seyfang (2011) have edited a collection of articles by recognised authorities in CC systems that discuss critically and in depth many CC aspects of current interest, including a classification of types in terms of 'generations' of CC systems. For the purposes of this discussion, however, it is sufficient to follow

[118] In 2004 the WIR was assigned its own symbol 'CHW' by the British Standards Institution and with the approval of the World Bank. CHF and CHW cannot be exchanged for each other but for accounting purposes 1 CHW = 1 CHF.
[119] http://data.worldbank.org/data-catalog/world-development-indicators?cid=GPD_WDI
[120] 1964, 1980, 1991, 2005: http://www.wir.ch/index.cfm?CBD9201D3DBB11D6B9950001020761E5
[121] 1993, 1997: http://www.qoin.com/achtergronden/barter-exchange-trade-mutual-credit-wir-irta-nate.html
[122] (Studer, 1998: 36)
[123] 2007: http://www.help.ch/newsflashartikel.cfm?art=News&key=232588&parm=detail

Solomon (1996), who points out that CCs can be implemented in two structurally very different ways, the LETS system and the Ithaca HOURS system. Each approach can be subdivided further into many more variations that depend on the specific choices and preferences of the community that designed it. In this section I focus more on the LETS model because it forms a basis for the discussion of the WIR.

LETS stands for Local Exchange Trading System.[124] When some years ago I met Michael Linton, who invented the LETS system, he explained that the idea of LETS came to him during an economic slump in Canada in the early 80s. He was living on Vancouver Island at the time, and noticed that the economic depression was accompanied by an absence of cash on the island. He posited that if someone arrived with a suitcase full of banknotes and started spending, within a few weeks all that cash would disappear, usually carted off to banks in the state capital.

A LETS system strikes at the heart of the problem of the diffusion of currency away from the periphery and towards the centre with a Gordian knot-like solution, i.e. by defining the total net amount of CC in a given community as exactly zero at all times (see Figure 6.4). Someone who sells a product or service is credited with a positive (credit) balance of so-many units of CC, whereas whoever buys that product or service acquires a negative (debit) balance of the same amount. Both changes in position are (usually) effected electronically, so that in most LETS implementations no physical currency actually exchanges hands. In most LETS implementations, likewise, interest does not apply and the exchange with the national currency is not allowed, so the only way to change one's positive or negative balance is to buy or sell, respectively, some other product or service, locally. Crucially, one does not need to be in possession of a CC in order to make a purchase: his or her balance simply goes negative by the price of the item or service, the provider's balance simultaneously going positive by the same amount. In reality, in LETS systems usually the participating shops tend to accumulate large positive balances that then they may have difficulty in spending, as shown in Figure 6.5.

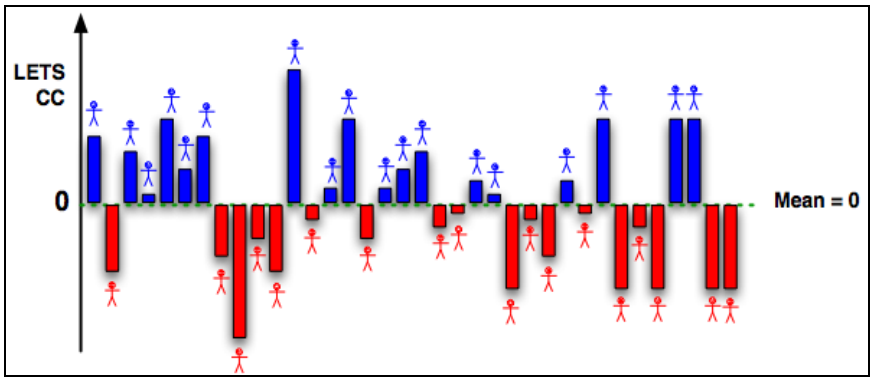


Figure 6.4: Idealised distribution of CC balances at one point in time within a given community using the LETS system

[124] Solomon gives the acronym as 'Local Employment and Trading System'. As explained by Croall (1997), this was the original meaning of the acronym, which was subsequently changed to Local Exchange Trading System. See http://www.openmoney.org/ or http://www.letslinkuk.net/index.htm for more on LETS.

There are some well-known problems with the LETS system, such as the fact that it does not scale very well since it benefits from and even depends on personal acquaintance, social ties, and trust between the members.[125] For example, the community extends a high level of trust to the individual purchaser in the hope that he or she will provide some other service or product back to the community in order to eliminate his or her negative balance. This property of the LETS system is also one of its greatest weaknesses since it leaves the community open to opportunistic free-riding behaviour, for example by someone who accumulates a very large negative balance and then disappears. This problem is exacerbated as the membership grows in size. As discussed by Jackson (1997), another related common problem is the tendency for a large majority of members to accrue a positive balance (Figure 6.6). This can be caused by weak accounting practices, but it is in any case an unstable rather than self-correcting process, since as the number of people with positive balances increases the number of people willing to sell services decreases since everyone wants to buy in order to lower their balances.

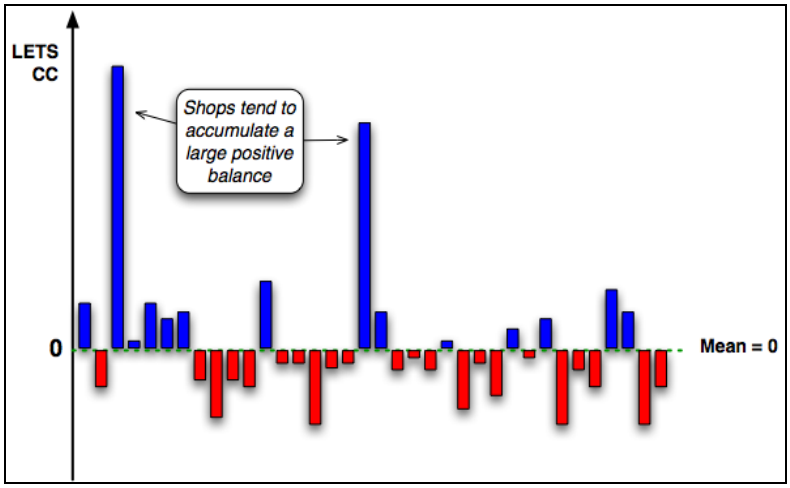


Figure 6.5: More typical distribution of CC balances within a given community using the LETS system

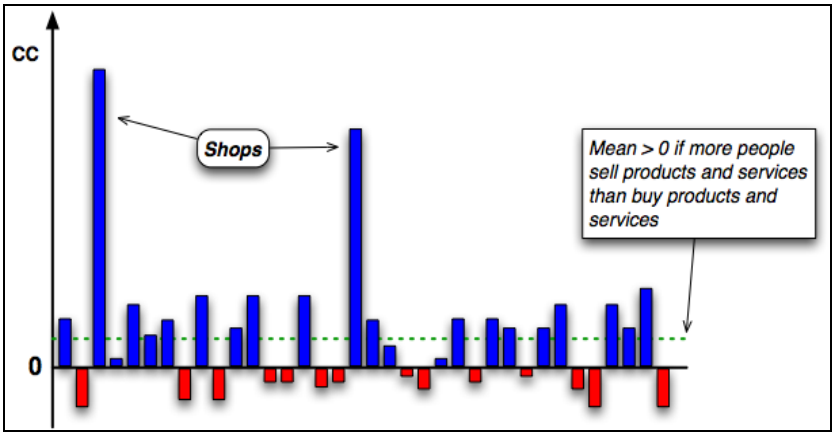


Figure 6.6: The problem of over-accumulation

[125] In general, a small volume is not necessarily a problem if it serves the needs of the local community, but it is a shortcoming in the context of our exploration of how to generate market ROI from CCs.

Schraven (2000) provides a fairly thorough comparison between LETS CC and national currency, which is partly reproduced in Table 6.2. The conclusion, also stated by Jackson (1997), is that LETS CC is in fact a form of money, rather than a magical way of creating something out of nothing, as some of the more enthusiastic promotional literature sometimes seems to imply. Therefore, standard economic and accounting measures should be taken to ensure that its use remains sustainable and the overall system solvent.

The other main type of CC is a physical currency whose definition follows more familiar criteria, such as being pegged to, and therefore being redeemable and exchangeable with, the national currency or a basket of commodities. An example of such a CC is the Brixton Pound.[126] Unlike the LETS system, with a physical CC there is no membership, the CC is usable by anyone who is willing to accept it, although usually this means that person lives or works within the geographical boundaries of the community.

Table 6.2: Comparison of economic functions of money and LETS CC

Money	***LETS***
• Unit of account • Store of value • Medium of exchange • Centralised supply of currency • Interest, hence commodifiable	• Transaction management • Credit • Market matching • Store of value • Local, distributed supply of currency since currency is "created" at the moment of purchase • No interest, hence not easily commodifiable

Source: Schraven (2000), with my additions

Figure 6.7 shows a simplified schematic of a possible circulation model for a physical CC, which can also be implemented in electronic form. The figure depicts the bootstrap situation as well as the interactions later on. When the system is bootstrapped an initial amount of CC is either freely distributed to individuals or exchanged by them for national currency. Later on the need to purchase CC notes or electronic tokens decreases since the participants can simply earn the CC through interactions with community members. These interactions could involve, for example, small jobs like painting a door or the sale of used items. People can also use CC to purchase goods at participating shops. All purchases involve some fraction of CC and national currency that ranges from 0% to 100%. The shops, in turn, have a choice whether to exchange the CC they accumulate in the till for Sterling, or to spend it themselves since they are community members like anyone else. Finally, anyone can still interact with the market economy in the normal way through wages or purchases.

[126] See http://brixtonpound.org/

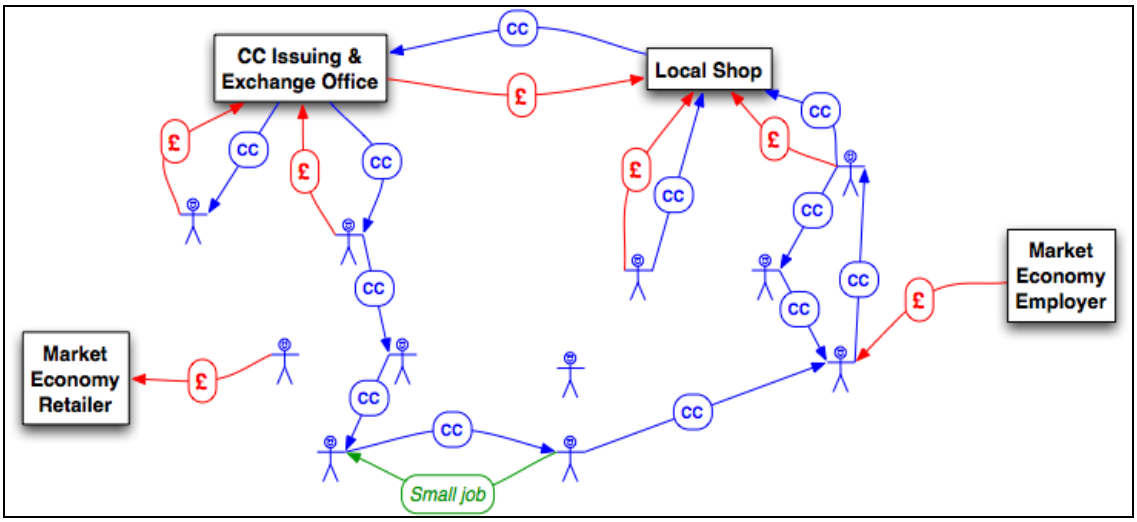


Figure 6.7: Simplified schematic of the flow of a physical CC

6.4 Import Substitution

Let us look next at the claim that CCs stimulate the local economies in which they are adopted, as this is potentially of significant interest to the superfast broadband debate. One way in which this phenomenon can be explained is through the presence of national retail chains and banks that offer their products and services locally but are likely to obtain greater returns from investing the corresponding revenue they accrue in other ventures or in other, richer regions than in the depressed town or island in question. As discussed, most CC systems aim to offset this phenomenon by creating a currency that is valid only locally and, therefore, cannot 'disappear'. By remaining local, it binds the local community through a tighter set of economic interdependencies or a greater number of economic transactions, which translate into a quantifiably greater local economic activity. Although one could argue that the global number of transactions in the overall economy, on average, has not changed, the device of a CC does affect the spatial or geographical distribution of economic activity, keeping more of it local. It is for this reason that CCs are said to 'stimulate' the local economy. Although the increase in local economy turnover happens at the cost of a fractionally lower efficiency of the overall economy, one could argue that this cost is much smaller than the benefits to the former. Schraven (2000) explains this effect in a slightly different way:

> 'The principal economic objective of a LETS is to facilitate "import substitution" in its locality in order to promote a local economy that is less reliant on external sources of goods, service and money' (Pacione, 1999: 68). In this capacity LETS is supposed to play the role of alleviating welfare implications of external shocks exacerbated by globalisation (Pacione, 1997). An economist might note that this 'benefit' really stems from 'trade diverting' not 'trade creating', i.e. re-dividing the pie, not increasing its size. That is true, however, that merely means that such systems may not be desirable from an overall efficiency point of view but can still be desirable for a small group. However, where such arguments may have some merit for small corporate bargaining groups, they are less promising for LETS. As soon as LETS grows to levels sufficiently large to facilitate a shield against globalisation through import substitution the individual incentives become very small. (Schraven, 2000)

In other words, the phenomenon of trade substitution is real, but it appears to decrease as the community becomes larger. Equally interesting is the fact that the phenomenon of import substitution for stimulating a local economy decreases in importance as the state of the overall national economy improves (Krohn and Snyder, 2008).

Schraven elaborates further:

> It is straightforward to construct a case where a convenient medium of exchange, such as the national currency, is drained from the local economy due to a trade deficit with the rest of the national economy. … Establishing a means of exchanging these non-tradables, of which the store of value is only redeemable locally, prevents all purchasing power to be transferred to more successful regions. This however, is not necessarily trade diverting but can be trade creating, because it facilitates exchange of non-tradables. … The essence of the problem is not that there is no money but that the *store of value* and *medium of exchange* functions of money are in conflict. (Schraven, 2000) [Emphasis in original]

In other words, the trade deficit drains the local community of the value stored in the national currency; but, by so doing, it also deprives the local community of a medium of exchange. At the very least, therefore, using a CC is a way to reinstate the latter without making unreasonable claims about the former. However, the point that CCs can facilitate the exchange of non-tradables is significant, since this is not just a diversion from one part of the economy to another, but a net contribution that would have remained unquantified otherwise. The fact that such a contribution is very small, does not change the theoretical interest of the phenomenon.

6.5 CCs as an Economic Phenomenon 'Far from Equilibrium'

The effect of a CC can also be understood from the point of view of General Equilibrium Theory. Whether a local consumer interacts with a local business or a national chain (such as a supermarket chain), a sizable proportion of the revenue flow arising from local trade is likely to be channelled to the banking system. Local businesses deposit their proceeds from sales and services in banks, and supermarkets use the time-lag between income from sales and the payment of their suppliers (usually 3 months) to generate an investment income from the former. In other words, a significant part of the revenue generated through local economic activity is managed by non-local agents who reinvest it into whatever they believe will generate the most profit for them. Unsurprisingly, this is seldom within the community from which the revenue comes.

If the same agents agree to participate in the use of a CC within a given locality, then a portion of their revenue will be in the CC rather than in the national currency. Whoever holds the CC revenue, regardless of whether it is a local business or a national chain, will need to find ways to spend it again within the community, perhaps in the form of wages, rather than depositing it in its bank account.[127] Therefore, as I

[127] It is of course also possible to create a special CC account managed by a bank, as discussed by Solomon (1996).

have already discussed a greater proportion of revenue will continue to circulate within the community instead of migrating to some other form of investment selected by the central office of the bank or the national chain.

If, for the sake of argument, we take the unhindered and spontaneous flow of revenue in the absence of a CC to correspond to the tendency to approach Pareto-efficient (or Walrasian) competitive equilibrium, the effect of a CC could be criticised as causing a distortion of the "free" market. However, it is well-known that Pareto-efficient competitive equilibrium does not necessarily correspond to the most equitable distribution of wealth or utility. It is partly for this reason that a fair amount of intervention, for example through taxation policy, has become routine. Short of that, various forms of constraints (e.g. supply-side constraints) can also cause distortions and are dealt with in the models through suitable mathematical techniques. In other words, a CC could be formalised as another constraint under which a particular objective function can be optimised.

So what is the difference from redistributive tax policy? In the public perception, it is the difference between hand-outs to a depressed region that come from a different, 'rich' region and the evolution towards economic self-sufficiency of the former. Thus, whereas under very idealised conditions the final GDP numbers could be argued to end up being the same, the different paths followed make all the difference in terms of fostering mutual respect between different parts of the country and self-respect within the poorer region, national cohesion, community identity, greater enfranchisement, and so forth.

This argument seems to hold better with a LETS-type CC than with a physical CC pegged to the national currency or to a basked of commodities, since in the latter case the exchange rates allow some of the locally held value to "leak" back into the centre through various market mechanisms. In any case, from a theoretical point of view this property of CCs is extremely interesting because it amounts to holding the economic system 'far from equilibrium', to use Ilya Prigogine's famous phrase (Nicolis and Prigogine, 1977) – even if the extent of present CC implementations is not in fact likely to cause a very large deviation from equilibrium.

As our understanding of complex systems increases, we are gradually becoming better able to understand and control phenomena that up to now have been only the province of unfathomable biological systems. The sophistication of our distributed software infrastructure and distributed computing power is making it increasingly possible to imagine a financial "nervous system" that can be tuned to maximise economic growth through the optimisation of dynamic phenomena that might go beyond the (relatively) simple approach to equilibrium.

One of the provocative research questions that we formulate in this paper, therefore, is whether smart solutions together with superfast broadband can begin to offer the conditions for such a more sophisticated economic dynamic. In this chapter we have seen a first hint that CCs may also play an important role, given their hybrid properties half-way between the social dimension and the market. This question addresses the first research objectives stated at the beginning of the chapter. In order to begin addressing the second, it is useful to develop a more comprehensive critique.

6.6 Further Critique of Community Currencies[128]

The establishment of a CC is far from trivial. The following are some considerations that would deserve to be addressed with some care. Some apply to physical CCs, others also to LETS systems.

- The issue of the currency must be conducted by some authority. This is because it has to be "issued" in a controlled way to prevent opportunistic issuance which would obligate all accepting the CC to provide goods and services in exchange for that currency. If control is not exercised, opportunism is likely to arise.
- The scope of acceptance – only those willing to accept a CC need accept it in payment (as compared to national currencies which typically operate under a "legal tender" rule which extinguishes an "obligation to pay" once legal tender has changed hands and therefore makes sales binding). Effectively, exchanges not made in legal tender remain "unresolved" in law. Closure or resolution of exchanges in "community currency" is not likely to be legally enforceable and therefore would require other means of dispute resolution.
- Although originators of a CC may have the intention to limit the scope to some other definition than "those willing to accept in exchange" there is no practical means of enforcing such a restriction.
- Although the originators of a CC may intend transparency and taxability, the enforcement of these provisions is only as good as the related institutions. Barter is a prevalent method for tax evasion, and CC could be used for the same purpose. For this reason some governments are not strong supporters of CCs.
- There is no logical reason why "community currency" would not give rise to interest. Interest is a social construct arising from the willingness of a party to accept deposits in order to lend the depositors' funds to others with the knowledge that not all depositors will ask for their funds back simultaneously. The Swiss WIR, in fact, has been accruing interest since 1952; the change was made to make it more compatible with the market and credit environment in which the participating SMEs (for whose specific support the WIR was created in the 1930s) were operating.
- There is no logical reason to believe that a "community currency" defined without a fixed commodity base (e.g. based upon precious metal reserves or some basket of commodities) would not give rise to currency markets. The exchange value between the store of value represented by the CC and actual goods and services is subject to fluctuation (a primary source of which is the prospect of an expanding issuance of CC). Markets in currency exist to bear the risk of these fluctuations. Commodity-based CCs also support such currency markets, but they are equivalent to commodity futures markets. Establishing a rate of exchange between community and other currencies only hastens the development of currency markets. Whether or not these dynamics can be regulated or perhaps "modulated" is not clear and warrants further study

I now turn to the most successful CC system to date, which has addressed some of the points indicated above.

[128] This section has benefited from comments by Ed Steinmueller, SPRU – Science and Technology Policy Research Unit, University of Sussex.

6.7 The Swiss WIR

WIR stands for Wirtschaftsring, German for "economic circle", but also means "we" in German, emphasising the community aspects of the currency. WIR refers to the club or network as well as to the currency itself, which is nominally held at the same value as the Swiss Franc (CHF) to simplify accounting. As explained by Lietaer (2001), the unit of account is the CHF, whereas the medium of exchange is the WIR or CHW. WIR was founded in 1934, as a result of the money scarcity caused by the Great Depression in Switzerland (Studer, 1998). It can be seen as a multilateral corporate barter exchange system, or as 'a centralized credit system for multilateral exchange, [or as] an informationally *centralized* exchange network' (Stodder, 2009; emphasis in original). A comparison with the almost universal reliance on the trade credit mechanism is also helpful.

It is possible that LETS was partly inspired by WIR, since the two systems share several features. They are both members-only networks. WIR utilises a negative balance system that is similar to LETS but different in important respects, and for small negative balances relating to the use of the currency itself no interest is charged by WIR to its members. The three main differences are

- WIR is mainy a B2B currency that was created specifically for SMEs, to make it easier for them to obtain credit especially in economic recessions.
- Whereas in LETS a member's negative balance is a debt towards the community, in WIR it is a debt towards the central credit clearing house, which since 2004 is called WIR Bank.
- In addition to allowing members to acquire a negative balance when making a purchase, thereby "creating" currency in a manner very similar to LETS, with the seller in the trade acquiring a correspoding positive balance, WIR also allows members to take out large and long-term loans, as large as house mortgages, for which interest (in CHF) is charged and collateral requested.

When a member company requests a certain amount of credit in order to effect a purchase from another member, the WIR bank issues what amounts to a short-term and interest-free loan, which is accounted for as a negative balance for the purchaser and a positive balance for the seller, just as in LETS. The actual mechanism is a credit note (nowadays an electronic transaction) that is sent to the central WIR bank by the seller. The bank then updates the balances of the members and charges 1% of the purchase price to the seller, which the seller must pay in Swiss Francs (Studer, 1998), generating an income stream for the bank. Stodder (2009) found that WIR exhibits a 'deeply acyclical' behaviour with respect to national money supply. In other words, in periods of recession when there is less national currency around WIR turnover increases. This insulating effect is believed to be one of the reasons for the stability of the Swiss economy (Stodder, 2009).

Because the WIR system operates in a manner that is in some respects similar to a bank, it also follows careful credit checks on companies petitioning to join. These checks were instituted in 1940, as part of a reorganisation that brought WIR under Swiss banking law, after the early version of the network came close to collapsing due to absence of collateral associated with large negative balances. In the early years WIR also applied demurrage, which was abandoned in 1948. Interest on large loans started being charged in 1952. Finally, in 1973 WIR credit discounting was prohibited, meaning that WIR credits could no longer be

exchanged for Swiss Francs, because it seemed to lead to a devaluation of the WIR as a currency. This is another feature that is similar to LETS credits. As claimed by Studer (1998), the structural characteristics of the WIR system combined with the flexibility of the members and supporters to adjust the properties and the rules over time enabled WIR to last so long.

Estimates of the size of WIR vary somewhat. In 1993, there were 77,000 business members or 17% of all Swiss businesses. In 2000 this number had grown to 85,000 or 20% of Swiss businesses.[129] According to Stodder (2009), in 2003 WIR had approximately 77,000 SME and household members. In any case, these numbers represent a significant portion of the Swiss private sector. Using 1993 numbers, Studer estimates an average acceptance rate of WIR credits of 40%. Thus, the 1993 WIR turnover of CHW 2.5b corresponds to a turnover in Swiss Francs of CHF 5.25b. He then sums up the economic contributions of WIR in terms of four categories of turnover:

1. Turnover that would have taken place in the same amount even in the absence of the WIR institution (i.e., WIR sales seen as mere substitution for lost cash sales);
2. Turnover based on domestic rather than foreign transactions, owing to the purely Swiss nature of the WIR (i.e. WIR members' purchase of Swiss goods and services instead of imports);
3. Turnover based on "buy-local" solidarity considerations that promote purchasing from small and medium-sized Swiss firms as opposed to large corporate sources;
4. Turnover stemming exclusively from the cash-free barter character of the WIR credit clearing system, i.e. that would never have occurred without WIR (Studer, 1998: 36)

Although it is not possible to know the relative magnitudes of these four categories, Studer believes they can all be assumed to provide an important contribution, implying that they may be of similar magnitude. 2 and 3 are forms of import substitution, whereas 4 is a net increase in GDP. Finally, Lietaer summarises the reasons WIR members give for using it as:

- It is a very cost-effective way of doing business: commission on sales is limited to 0.6% on deals completed in WIR [in contrast with Studer who says it is 1%];
- It gives access to a pre-screened and loyal client base; credit is much cheaper than in national currency;
- Other services are provided (direct-mail, publicity among members, publications, etc.);
- It offers a buffer against exterior shock, such as a sudden increase in the national currency interest rate, or other economic disasters;
- It is a way for small businesses to gain some of the advantages to which otherwise only big businesses have access. (Lietaer, 2001)

[129] http://www.qoin.com/achtergronden/barter-exchange-trade-mutual-credit-wir-irta-nate.html

6.8 Use Value and Exchange Value Revisited in an Institutional Context

The points I have discussed so far in this chapter highlight the need to integrate CC implementations with a fairly complex mix of policy, regulation, legal and enforcement provisions, and accounting mechanisms. This corresponds to the empirical evidence, as for example discussed by Croall (1997), suggesting that CCs require a significant level of institutional support in order to continue operating. If CC systems can indeed scale up as the WIR has done, then some of the theoretical questions formulated in this chapter acquire a greater potential practical relevance. Like most CCs, WIR has taken steps to de-emphasise the store of value function of their currency. In other words, the WIR is less commodified than national currencies, although more than the LETS system. This seems to have strengthened the social and institutional awareness of the members whilst maintaining the system more compatible with the market economy.

Another point we can extract from the foregoing is that at different scales the character of successful currency systems appears to change, suggesting that different scales come with different requirements. LETS systems do not appear to scale well. The WIR system, which does and whose upper size limit has not actually been tested since it has always been confined only to Switzerland, has properties that are closer to a national currency. At the smaller scales of LETS systems, shared perceptions of use value and exchange value seem to converge, and profit and accumulation are pointless.[130] Here the social dimension is very visible and dominates the economic. At the larger scale of WIR, some of the social relationships remain, but the size of the system requires a level of accountability, governance, and discipline that, in turn, enable it to support and mediate market exchanges of significant magnitude. The transition between the pre-1940 WIR, which was much closer to a LETS system, and the post-1940 WIR, which accepted to come under Swiss banking law, is that the enforcement of discipline (for example in credit checks on prospective members) increased the perception of its trustworthiness, which motivated a significant capitalisation by its members; this, in turn, enabled the size of the transactions and the loans supported by the WIR association to grow in size.

In other words, because WIR issues low-interest loans and does not solely perform a credit clearing function, its internal workings are subject to Swiss banking law, which has probably contributed significantly to its institutional stability over its 70+ year history. The balance between bottom-up governance of the WIR by the members and the top-down regulation by Swiss banking law is reflected by its balance sheet. As explained by Studer (1998: 34), at the end of 1997 the difference between the WIR and mortgage assets and the interest-free WIR liabilities (i.e. the circulating WIR currency) was about CHF 41m. Studer explains that this positive balance is the result of the greater number of services the WIR Bank performed for than it received from its members during its long history. If the business were to be shut down, this sum would become net holdings in Swiss Francs and would cover entirely the company capital, therefore serving as security. Although at the beginning the WIR was set up as a non-profit association, subsequent capitalisation drives brought it to issue interest to its shareholders, in 1997, at a rate of approximately 7% (Studer, 1998: 35). However, it has remained private, with the ownership structure of a cooperative, keeping the drive for

[130] As discussed above, over-accumulation of CC capital is actually a problem the hinders the effectiveness of the currency.

profit at a level that balances a reasonable return for its shareholders with the long-term stability and low-risk of its operations. Thus, also in the economic dimension the WIR strikes a healthy balance between the two extremes of the absence of profit of the LETS system and profit-seeking commercial banks – whose distinction from investment banks was becoming increasingly blurred until the 2007-08 banking crisis (Breitstein and Dini, 2011).

All this suggests that the relationship between use value and exchange value is affected differently at different scales by choice of exchange form and, as discussed by Jackson (1997), by social and cultural norms. In any case, the WIR system seems to come out well ahead of other CC alternatives as a candidate for capitalising on the social dimension to strengthen the market.

The first part of the argument of this part of the paper has now provided some evidence that there is much to be gained from striking a balance between the social and the economic dimensions of society, and has offered an institutional example of why this might be the case and of how this might be achieved in practical terms. The scale of the WIR is relevant to the outlying areas of the UK which will be receiving superfast broadband, but so far the discussion has been limited only to the material economy. Thus, the next step is to see whether a similar balance might apply between the information society and the knowledge economy, where we find a growing importance of non-market modes of production. This suggests that, before we can attempt to map the WIR experience to the digital economy we should take a closer look at the latter. I do this again from a starting point in the material economy, by pursuing a perspective that can rationalise broader conceptions of value within the same economic framework. The next chapter makes an attempt in this direction, whereas Chapter 8 then returns to a discussion of CCs.

7. BROADER CONCEPTIONS OF VALUE

7.1 Posing the Problem

The discussion in Chapter 5 is related to Benkler's work, in particular his *Wealth of Networks* book (Benkler, 2006), a broad and insightful critique and commentary on how the information society characterised by the Internet is finding its bearings in the presence of the market-based incumbents of the knowledge economy, especially in the area of cultural production. After pointing out a shift that has been on-going for about 100 years towards an economy centred on information production, and that has greatly been accelerated by the Internet, Benkler argues convincingly for the growing importance of non-market modes of production:

> What characterizes the networked information economy is that decentralized individual action – specifically, new and important cooperative and coordinate action carried out through radically distributed, nonmarket mechanisms that do not depend on proprietary strategies – plays a much greater role than it did, or could have, in the industrial information economy. (Benkler, 2006: 3)

And has some negative things to say about the market view of information:

> Even as opulence increases in the wealthier economies – as information and innovation offer longer and healthier lives that are enriched by better access to information, knowledge, and culture – in many places, life expectancy is decreasing, morbidity is increasing, and illiteracy remains rampant. Some, although by no means all, of this global injustice is due to the fact that we have come to rely ever-more exclusively on proprietary business models of the industrial economy to provide some of the most basic information components of human development. (Benkler, 2006: 14)

However, his view ultimately balances market and non-market action:

> This is not to say that property is in some sense inherently bad. Property, together with contract, is the core institutional component of markets, and a core institutional element of liberal societies. … Commons are another core institutional component of freedom of action in free societies, but they are structured to enable action that is not based on exclusive control over the resources necessary for action. … Each institutional framework – property and commons – allows for a certain freedom of action and a certain degree of predictability of access to resources. Their complementary coexistence and relative salience as institutional frameworks for action determine the relative reach of the market and the domain of nonmarket action, both individual and social, in the resources they govern and the activities that depend on access to those resources. (Benkler, 2006: 24)

Since Benkler's background is law, in his book he then makes general suggestions that are relevant to political and regulatory perspectives, in the interest of protecting individual liberal-democratic freedoms. His work focuses on highlighting the freedoms of individuals in the informational public sphere, on how such freedoms affect the abilities of individuals to provide and receive information outside the market, and on what the government might do about the encroachment of the market on these freedoms and abilities. In

other words, Benkler is concerned with building a protective wall to enable the new modes of production enabled by the Internet to flourish.

In his analysis Benkler stops short of defining a new concept of economy. He says value is being created outside the market but then does not provide a 'place' where such value can flow, other than the social and the cultural, by default. Whereas from the point of view of national policy this ought to be sufficient, in the context of a discussion on superfast broadband private-sector investors in Internet infrastructure may be left wondering how they are going to recoup their investments other than by feeling good about its philanthropic effects. The lack of a straightfoward answer to this apparently simple question motivates us to extend the scope of the search, in this and the next chapter. Benkler seems to keep the categories 'social', 'cultural', and 'economic' separate and does not seem to attempt the development of a unifying framework, although he provides many tantalising examples of productive interactions across these domains. In this chapter and the next I suggest that such a deeper level of integration may bring us closer to unlocking the very significant amounts of value generated by the new Internet-enabled phenomena. Whether we can then translate it into a more productive and measurable interaction with the market economy is an additional, and more difficult, question that this paper aims to make a positive contribution towards.

7.2 Extending the Economy beyond the Market

The considerations discussed in Chapter 1 around the value map (Figure 1.1) are compatible with a trend to look beyond the market that has become more popular in recent years, especially with environmental concerns and the recent financial crisis.[131] The motivations for extending the scope of the concept of "economy" beyond the market are various, ranging from politics to business innovation, but what could arguably be regarded as the most important motivation remains rather subtle and difficult to understand because it challenges the preconception "Economy = Market" that has by now become deeply ingrained in the collective consciousness.

As long as we identify the economy with the market, most of the effort at policy level will, understandably, continue to focus on making the market work. The role of the social dimension will therefore remain unclear: as an output of the economy, the social dimension *ought* to benefit from the market, at least in times of boom, but as an input to the economy it is widely recognised to be essential to business and economic health[132] whilst remaining incommensurate with it. This places societal concerns in a subordinate and confusing position relative to the economy: dependent on it whilst at the same time important for it but unable to contribute to GDP in a direct and quantifiable way.

As mentioned in Section 5.3, the amount of work on the quantification and the economics of non-monetary incentives is significant. Especially in business environments innovative thinking has had positive effects on

[131] For instance, see 'The Great Transition' (New Economics Foundation, 2010), OECD's Better Life Initiative (http://www.oecdbetterlifeindex.org), or Molloy (2011).
[132] See for example Granovetter (1986) or Polanyi (2001[1944]).

the interaction between the private enterprise and society. Over the past 30 years, corporate social responsibility has gradually turned from spin and marketing strategy to good business. Yet, in the middle of this positive transformation, the average layperson's understanding of matters economic has remained rather shallow. In democratic societies this leads to a problem in that politicians need to pose and address economic problems in terms their electorate can understand. There is a disparity between the outlook of the most innovative enterprises and community initiatives, on the one hand, and of government economic policy, on the other.[133] With the increasing political awareness of individual citizens brought by the Internet, the need for accountability on the part of the same politicians, especially in times of economic crisis, has also increased. This has led, for example in the rhetoric used by most American presidents as they prepare for re-election campaigns, to a tendency to avoid more complex 'academic' discussions and to keep as much as possible to an 'objective' and quantifiable characterisation of the problems and the solutions. If we couple these effects with the political polarisation brought about by 70 years of Left-Right rhetoric in often sterile political debates, during the 20th Century, it is small wonder that 'market speak' predominates in public debates about the economy.

I suggest that in order to reach a more productive debate around superfast broadband the *language* of economics needs to be extended, as a starting point. By affording equal legitimacy to understandings of the economy that have until recently been excluded, the field of economic action is expanded. The result could be a safer passage towards 21st-Century societal goals and government promises that market thinking by itself seems increasingly inadequate to fulfil at both national and international levels. Ironically, rather than a rejection of the market concept, such a Polanyi-style transformation is well-placed to lead to a *different* kind of market in which the economic and social spheres are more tightly and more visibly integrated and interdependent.

The discussion in the present paper is more focused on how socio-economic growth and transformation can be mediated and modulated by information and communication technologies (ICTs), and in particular by superfast broadband. Policy makers at all levels in the UK and internationally place great emphasis on the role of ICTs and in particular broadband, for stimulating economic growth (as in UN (2010a) and UN (2010b), for example). However,

> [l]ittle attention is given to evaluating what a configuration of market and voluntary activity in the media and communication sector is likely to enable people to accomplish in their lives, much less to the economic resources and other capabilities they need in order to benefit from their access to ICTs and digital information. (Mansell, 2012)

In this paper we have placed as much emphasis on some of the other factors Mansell refers to, which we regard as at least as important as the role of broadband. Accordingly, I introduce a broader conception of the economy that can better account for the role of the concepts on the left of Figure 1.1, and I then examine how these may be affected by superfast broadband. The first challenge is to provide an economic system

[133] The role of private financial institutions such as investment banks is likely to make matters even more difficult, but taking that into account in this discussion would take us too far away from the focus of the paper.

framework that can encompass all of Figure 1.1. The second challenge is to fill in the framework for the digital economy.

7.3 Economy as Domains of Value

An extension of systemic economic relationships beyond the market has been developed within the field of economic anthropology, for example as discussed by Gudeman (2001). Economic anthropologists study the forms of value creation and exchange that characterise different human cultures, including the Western. All economies strike a balance of market or commodity-based production and exchange and non-market and commons-based production, sharing, and exchange. But Gudeman proposes a more granular classification of value domains which, importantly, is also dependent on scale: (1) base or commons, (2) social relationships, (3) accumulation or capital, and (4) trade or market. The first two are prevalent at smaller scales and are closely associated with community, whereas the latter two tend to involve longer-distance interactions and are more impersonal. However, the domain of accumulation is equally important for community and for the market.

The dependence of the value domains on scale is well captured by Figure 7.1, which shows a schematic that extends and adds to Gudeman's own graphic of how a local economy based on use-value relationships can interface to a wider market economy that can span and connect multiple communities. The diagram shows a rather intricate interdependence between different parts of the economy, of which the market is emphatically only a part and in which the value of social relationships can be recognised to have a central role. In such an economic framework the market exchange of commodities coexists alongside other economic mechanisms such as the sharing of public goods, barter, gifting, and reciprocity. The figure also implies that different mechanisms are operating at different scales and in different institutional contexts.

To begin understanding this figure it helps to note that 'the base in a system of social value is the counterpart of capital in a system of commercial value' (Gudeman, 2001: 33). Unlike commercial capital which is usually measured with a common metric, i.e. money, the values in the base are measured in many different ways that depend on the type of base and the type of community. However, the function of base and capital to "store" savings that, for example, can be accessed in hard times is analogous. The figure shows the domain of accumulation as belonging to the scale of community because Gudeman's perspective emphasises the real economy rather than the economy of financial markets. The fact that his object of study has predominantly been the village community in various "developing" countries probably also influences this interpretation, although of course for an anthropologist a corporation is a community too.[134]

[134] Another shortcoming of this diagram is that it does not address the labour market explicitly. This is not surprising since it was developed mainly through the ethnography and analysis of agrarian economies. Regardless of whether we choose to think of labour as Marx's 'surplus value' or as Polanyi's 'fictitious commodity', labour is arguably the most important 'glue' or 'currency' that connects and strengthens the interdependencies between all four domains. This seems all the more so in 'post-industrial' service and knowledge economies.

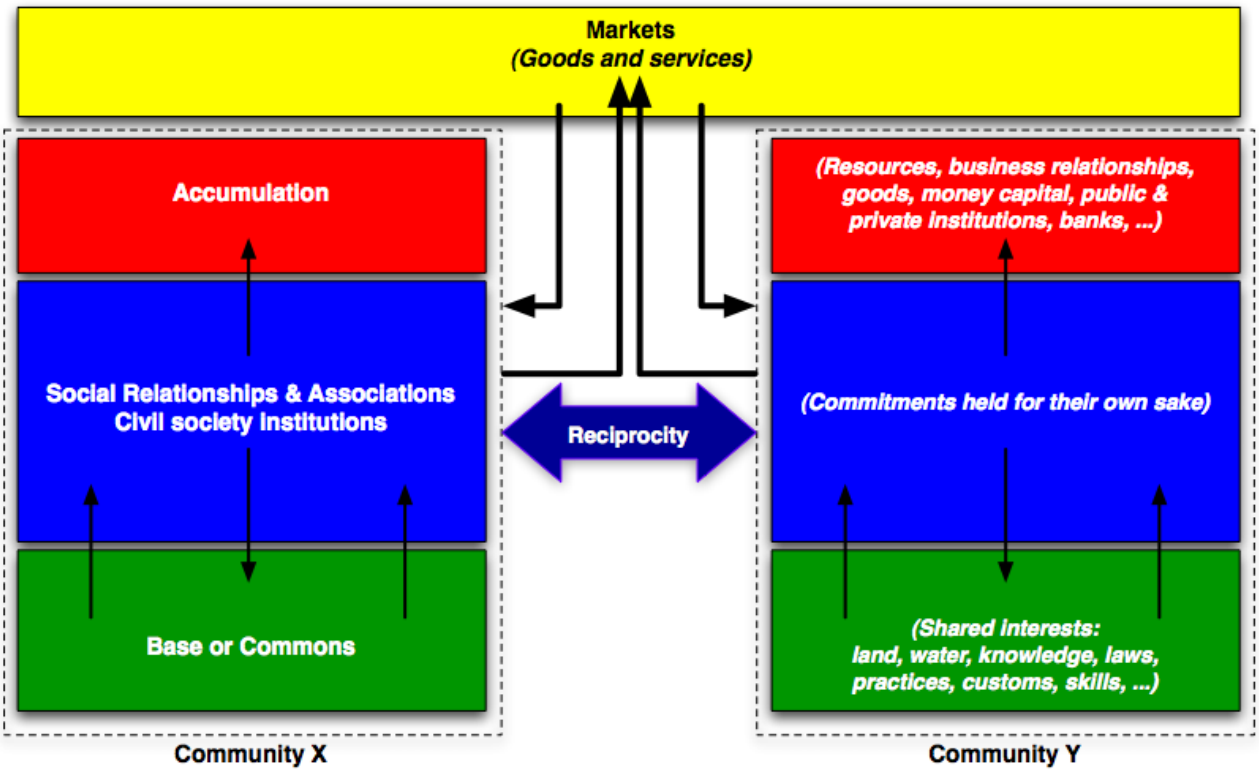


Figure 7.1: The four domains of value in economic anthropology (based on Gudeman, 2001)

But the reason for using Gudeman's ideas is not to provide the ultimate model for a Western industrial or post-industrial economy, so the fact that it may not be complete is not at issue in this discussion. Rather, our two-fold objective is (1) to show the greater expressiveness of a model that involves domains of value beyond the market; and (2) to show how economic anthropology has been able to uncover interdependencies between different value domains that hint at the possibility of connecting all of them into a single, stable, and self-regulating system. The ironic inference from the latter point is that the ideal of the 'self-regulating market' might have been based on a valid intuition all along, but appears to have suffered from a limited understanding of the complexity and subtlety of the concept of economy, which in most cases has been – and continues to be – reduced to the market.

Gudeman's ideas are only one way of representing the extension of the economy beyond the market.[135] We might choose instead to concentrate just on the facts, familiar to us from our everyday lives, that there are other values and other transactions besides those found in the market and that there are other communities and other scales of operation besides those formalised as the nation state and the workplace.

Although Gudeman's book is far from addressing every aspect of modern economies, it suggests a way to see our social and cultural dimensions through an economics lens. The relevance to the present discussion of such a unifying view lies in providing an example of crossing boundaries between disciplinary perspectives that have mostly been considered to be incommensurate. By legitimising additional domains outside the

[135] For instance, the emphasis on the role of communities with social norms is found also in institutional economic studies.

market as integral parts of the economy, the latter is enlarged; and by showing how different domains of value can work together local economies are more likely to discover new sources of sustainability. In the remainder of this chapter I will therefore explain Gudeman's more complex conception of economy emphasising its systemic properties, and will end with a section on how such a model might map to the digital economy. Building on this discussion, Chapter 8 will then propose some ideas that aim at connecting the four domains of value in the digital economy, addressing specifically the challenge of their incommensurability.

7.4 Gudeman's Four Domains of Value in More Detail

Table 7.1 provides a summary of the four domains, their constitutive and interaction characteristics, and the theories and systems of ideas used to analyse and make sense of them.

Table 7.1: Summary of the four domains of value

Value Domain *(Scale)*	***Description***	***Types of Interactions***	***Relevant Theories & Disciplines***
Base or Commons *(Community)*	The base or commons can be different things depending on the economic system of choice or the definition of community. For example, for a family it is the house, the land the family owns, the baby pictures, the kitchen utensils. The base can also be made up of things that a family unit, for example, needs to survive, such as the products of subsistence farming, which are generally different from 'cash crops'. For a village, it could be the common pasture, i.e. the proper 'Commons' of old. In general, the shared interests: lasting resources such as land and water and ideational constructs such as knowledge, technology, laws, practices, skills, and customs. Also, cultural agreements and beliefs that provide a structure of the other three domains. All these are unpriced and add up to community identity.	Sharing, gifting, bartering, saving, & economising, take place within a community. Reciprocity, meaning the exchange or extension of the base, takes place between communities.	Psychology, Sociology, Cultural Anthropology, Behavioural Economics, Public Goods Theory
Social relationships *(Community)*	Social relationships and commitments are maintained for their own sake (although they can also become instrumentalised for economic, business, or political ends). The generalisation and applicability of this idea to civil society associations can be seen as a symptom of a given society's ability to uphold its 'social contract'. This is generally dependent on a minimum level of trust and, in turn, can then reinforce the reciprocal trust within a community. Reputation and social standing are values that belong to this domain. Social relationships mediate the transfer of materials and services.	Reciprocity, obligations, caring, trust, respect, commitments	Psychology, Sociology, Social Anthropology, Political Science, Institutional Economics, Gift Economy

Accumula-tion *(Community & Global)*	Accumulation contains all forms of capital (money, material, social, cultural, intellectual) but also memory-based traditions and customs. From a systems theory point of view (Von Bertalanffy, 2003[1928]), such a generalised concept of capital in social science[136] can be understood more as a 'potential', such as the future purchasing potential of money, or as a memory, which manifests itself in the accumulation of traditions and social, economic, and political institutions. Accumulated value is held, invested, consumed, and displayed. Sustained and justified by economic power, social obligations, and ideologies. In capitalist economies private property provides the fundamental rationale for accumulation.	Arises through profit, rents, interest, tithes, monopolies, arbitrage, and innovation	Neoclassical Economics, Anthropology
Market *(Global)*	Goods and services are traded in the market by individuals or groups, for production or consumption. The market generally operates at the largest scale. It tends to be globalising, impersonal, and relatively easy to formalise into contract law and quantifiable transactions through the use of money as a medium of exchange. Participants are individuals, corporations, partnerships, households, families, kin groups, etc.	Money-based exchange, but also barter, commodifica-tion	Microeconomics, Macroeconomics

Source: Gudeman (2001) with our modifications

As a final visualisation effort, Figure 7.2 shows how the concepts of Figure 1.1 could be mapped to Gudeman's value domains. The mapping is far from straightforward because it is partly subjective and because several of the items straddle multiple domains, such as employment (Market and Social Relationships), friendship (Social Relationships and Social Capital), or democratic values (which emerge through social processes to create the foundations of democratic society). Land is shown in red because it refers to land ownership by individuals, which is normally considered a form of capital. The same concept at the level of the country would need to include the National Trust, and would therefore also be tinted in green. In the middle layer, finally, Land should probably be tinted in red and yellow.

The motivation for working with the value domains in spite of these difficulties when they are applied to the UK economy and society is that they provide a way of thinking and rationale that makes it possible to give the more socially and culturally-oriented kinds of value a primary role in the economy, thereby enlarging the latter and improving economic sustainability. An example of how this might be achieved is discussed in Chapter 8. The motivation for developing this line of thinking is to deepen our understanding of the case for superfast broadband.

[136] For the sake of clarity, economics is one of the social sciences, although in the business and technical literature social science is often identified more narrowly with sociology and political science. Other disciplines that stand with at least one foot in social science are social psychology, media and communications, law, anthropology, geography, history, organisation science, management, etc.

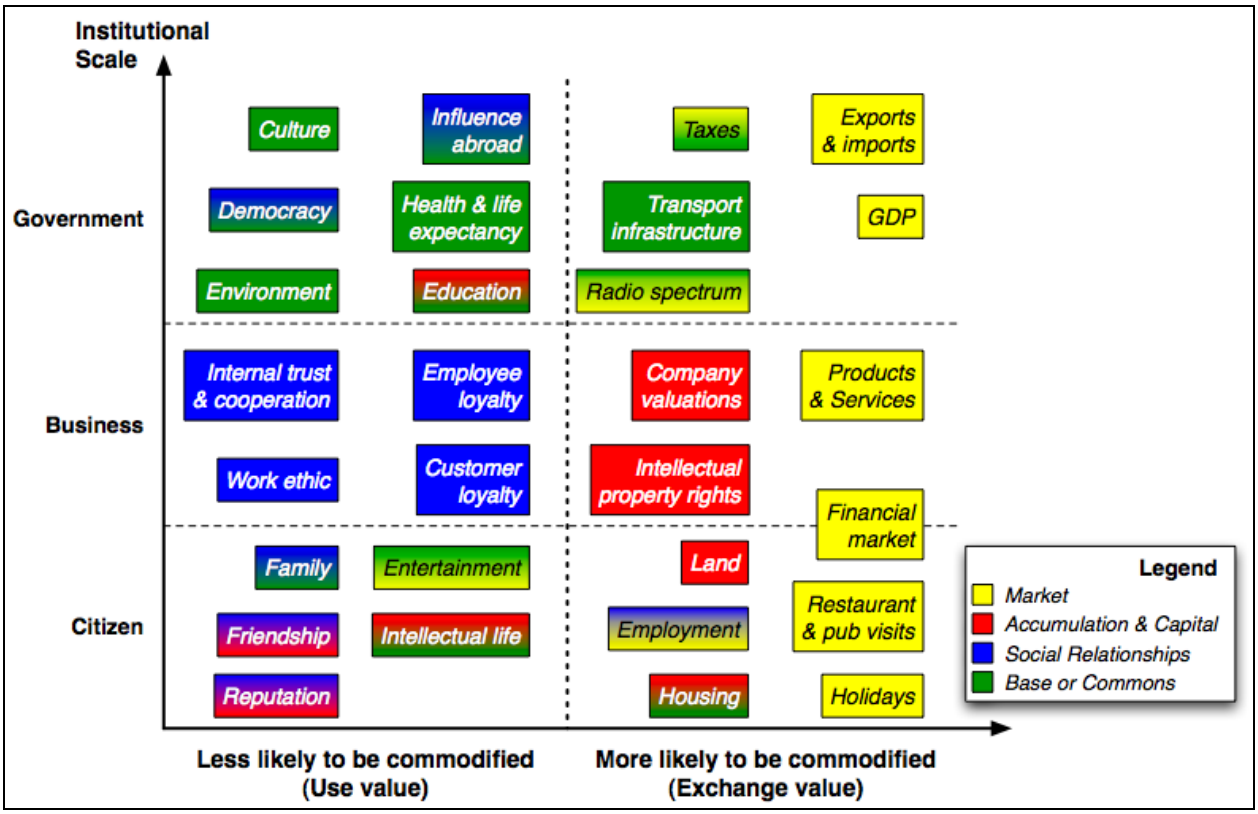


Figure 7.2: Gudeman's value domains mapped to the value map

7.5 The Four Domains in the Digital Economy

In the online or digital economy there are many forms of value that can also be organised according to the same classification. These categories and what they contain are not nearly as stable as what Gudeman found in agricultural economies hundreds or thousands of years old. For example, the types of content and the means by which it is created and shared or exchanged are continually shifting, in response to technological, social, and economic innovation. The concepts shown in Table 7.3, therefore, are only a representative sample of the possibilities. Another challenge in filling in this table is that the concept of private vs. public good is slippery in online spaces. For example, it is not entirely clear whether the pictures that are uploaded to one's Facebook page belong to the holder of the account or to Facebook. And yet, whatever the fine print might say, those photos are contributing to the base of the holder's community or social network. In other words, legal definitions of private property that extend over indefinite time-scales might not be immediately relevant to the formation and dynamics of online communities over time-scales of weeks or months.

The role that subsistence farming plays in the base of an agricultural community can be compared with, in the digital economy, psychological well-being, which is also strongly dependent on social standing, recognition, and acceptance. The fact that different crops are used for the base and the market might translate into what we do with different kinds of photographs. For example, the pictures from the latest party or family gathering are shared and exchanged free of charge within one's Facebook community or social network. However, the same person might be a freelance photographer who sells her (different) photos to a newspaper in a market transaction.

Table 7.3: Example of the four domains of value in the digital economy			
Value Domain *(Scale)*	**Description**	**Types of Interactions**	**Relevant Theories & Disciplines**
Base or Commons *(Virtual community)*	Tacit knowledge, open knowledge, public databases, Wikipedia, YouTube content, Facebook data	Knowledge sharing	Psychology, Sociology, Cultural Anthropology, Behavioural Economics, Public Goods Theory
Social relationships *(Virtual community)*	Facebook communities and other social networks, discussion forums, Twitter, e-mail	Friendship, kinship, gossip, personal politics, community building	Psychology, Sociology, Social Anthropology, Political Science, Institutional Economics, Gift Economy
Accumulation *(Virtual community & Global)*	Intellectual property, patent portfolios, copyright, number of LinkedIn links, social capital, online content, Second Life property, search engines (as they assist in knowledge construction through data retrieval)	Produced through innovation, artificial creation of scarcity (e.g. enforcement of copyright for online publications), artificial creation of desire, as well as standard accumulation of profit	Neoclassical Economics, Anthropology
Market *(Global)*	B2B/B2C services, information/knowledge services, retail	Online payment, subscription, advertising	Microeconomics Macroeconomics

7.6 The Perspective of Economic Anthropology

The tendency in the 20th Century, during what we could call the golden age of Neoclassical Economics (in the West!), has been to describe, analyse and quantify the four domains of value using concepts and tools that apply to the market domain. The result has been a widespread perception that everything can find an instantiation in a market or as a market. This perception was of course strongly influenced by the classical economics ideal of the self-regulating market, which was dominant in the West in the 19th Century. Policies of privatisation, which have been dominant in the West since 1980 and through the influence of the IMF, have had a major impact also on the rest of the world and are a natural consequence of this interpretation of economy. While it is certainly true that any of the materials or interactions in any of the four domains can be referred to in monetary terms, in most cases this results in a perception that some of the original value has been lost – hence the use of the verb "to reduce" something to a market transaction. Using monetary quantification is like characterising an object through its shadow: while the shape of the shadow does contain useful information about the object, much information is lost, such as its depth and colour.

This perceived loss of value is more accurately described as a translation from one form of value into another. For example, a family experiencing economic difficulties may be forced to sell off the family silver. The value to that family of its silver may be enormous, for example through its associations with many prior generations. The value of that silver in GBP is a 'projection' of a huge emotional/historical value onto a few

hundred (or thousand) pounds. The two categories of value are incommensurate in the sense that one cannot measure the subjective value of a family heirloom in the national currency. To that family it is "priceless". Yet such a translation is possible if one has no choice but accept the "reduction" to market/exchange value. By contrast, an artistic creation might not have a great deal of value for the artist or his/her family but, depending on who the artist is, its market value could be enormous.

The fact that the exchange between the forms of value often leads to loss strengthens the claim that some of the four domains of value are more commensurate than others[137] and that, therefore, it is wiser to maintain their individual structure and rules than to reduce everything to the same "currency". A prime example where two domains (Base and Market) have been connected without sacrificing the value metrics of either, and which is largely responsible for bringing this issue to the fore, is Open Source. The Open Source phenomenon spans all four domains (i.e. also social relationships and accumulation), but in its more recent manifestations the remarkable fact is that it appears to have been able to reconcile the commons and the market.[138]

Switching perspective, rather than attempting to reduce everything to the market, economic anthropology places *humans* at the foundation of the wider conception of economy shown in Figure 7.1. In effect, the "exchange mechanism" between the four domains becomes the subjective and necessarily variable human perception of value. Although this might seem too arbitrary to make sense, the whole concept of the market is based on a similar idea, that is, the exchange value of a commodity is necessarily a subjective assessment which reflects differences in perception of its use value by different people/agents.

Based on the discussion of Chapter 6 we might tentatively conclude that in the different domains of value the relationship between use value and exchange value changes. In the commons and social relationships domains, perceptions of use value tend to be shared by actors or participants, thereby making, by definition, exchange value coincide with use value. In the market and accumulation domains differences in perceptions of use value are much more likely. Such differences, similarly, give rise to exchange value, which becomes analogous to a potential difference and driver of the market seen as a dynamic process.

Gudeman does not go as far as providing a normative "system design" for how the economy should actually function. His work, however, provides us with inspiration for attempting to connect the domains as they apply to the digital economy, for example using a CC similar to the WIR to connect its non-profit-oriented parts to its profit-oriented parts through the same currency. Alternatively, Gudeman's framework can help us analyse the experience of the cooperative banks (on the continent) and of the building societies (in the UK) over the past couple of centuries quite apart from the use of any CC. I turn to these questions in the next chapter.

[137] For example money capital, which belongs to the domain of accumulation, is commensurate with the market domain.
[138] See Sections 1.3 and 7.4. Berdou (2011) provides an in-depth discussion of the latest trends in open source organisations and business models.

8. FURTHER AHEAD: SMART SOLUTIONS AND COMMUNITY CURRENCIES?

8.1 A Historical View on New Forms of Business Models

The insights provided by economic anthropology may most easily be expressed in terms of new business models. In reality this is not such an original idea, since new business models that point in this direction have been emerging for a while under the more modest label of "innovation": Crowdsourcing and Open Innovation are familiar examples, in addition to the already-mentioned open source models whereby a group of companies collaborate freely to the development and maintenance of an open source toolkit (e.g. GStreamer) or platform (e.g. Plone Content Management System (CMS)), whilst competing with each other by developing and offering their own proprietary services and applications that utilise the same toolkit or platform. In other words, the integration of the social dimension in a business activity is not a new idea. As we saw in the preceding chapter, economic anthropology enables us to talk about it as another form of economic value, rather than a form of social value. The problem, however, is that these two forms of value remain largely incommensurate. In this chapter I develop the idea that CCs provide a "return loop" from the market back to the base, tightening the feedback between all four domains and in part serving as an "exchange mechanism" between the four kinds of economic value.

In the history of credit-granting communities over the past three centuries, what makes the WIR system unusual is the use of its own currency. The fact that WIR has gradually morphed into a bank, however, highlights its similarity with a much larger phenomenon, the cooperative bank. The cooperative bank is another example of an institution in which the social and commercial dimensions are closely interdependent. Regardless of their legal and ownership structure, i.e. regardless of whether they are owned by their members or by external shareholders, for cooperative banks profit-making is not a central objective:

> European cooperative banks, in order to increase their efficiency and ability to operate, have continued to adapt to legal, technological, and market changes and to rely on a locality-based business model. This is a model in which the capital holdings of the bank are "patient", i.e. they are not expected to generate the maximum possible investment profit in the shortest possible time. Further, as an expression of "democratic" bank governance, such model becomes an instrument for achieving significant economic and social results for the whole community, through close and lasting relationships with all the stakeholders. (Fratta Pasini, 2005 [translated from Euro-English by the author], quoted in Marchetti and Sabetta, 2010).

In the UK[139] a similar phenomenon took the form of building societies, which originated in the North of England and the Midlands in the 18th Century in order to support the house-building of their members. While at first these were "terminating" building societies, which would dissolve once all of their members had

[139] This paragraph summarises a few points that are explained in more detail by Stefanelli (2010), a work which is complemented by Devine's thorough discussion of smaller cooperative banks in the UK (Devine, 2006[1908]).

succeeded in building their house, by the 19th Century permanent building societies became common. By accepting new members as old members completed their building projects, over time these became increasingly similar to commercial banks. However, since they did not have to pay dividends to shareholders they could offer lower interest rates on loans and mortgages, which partly explains the longevity of the phenomenon.[140]

The jointly owned cooperative bank or building society exemplifies an interaction between Gudeman's domains whereby the **base** (pooled land or property collateral) and the **social relationships** that define a particular community of members work together to support **capitalisation** and/or **market activity**. By creating credit for their members at a lower cost, these cooperatives or societies provide a protected time-window in which the members are given a chance to overcome a temporary cashflow shortfall or to build through labour the capital that will repay the debt. Where in an economic model based only on the market this benefit comes at the cost of a (relatively higher) interest on the loan, the joint ownership model can afford lower interest rates because this benefit is repaid with a "social" currency, for instance in the form of solidarity, upholding of community values, and so forth. Figure 8.1 illustrates the idea graphically for an agricultural cooperative bank and a building society.

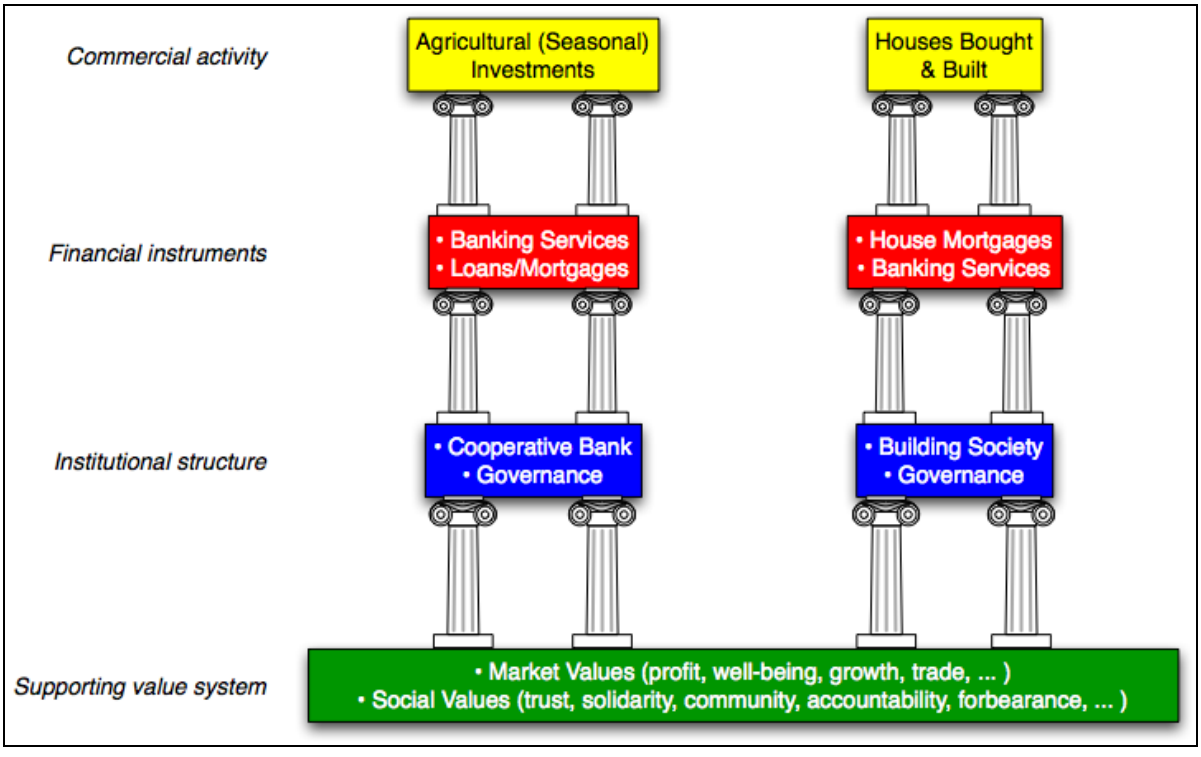


Figure 8.1: The roles of the base and social relationships in supporting capitalisation and the market

[140] The fact that many building societies such as Halifax, Abbey (now part of Santander), etc have now "demutualised", i.e. they have chosen to abandon the member-based ownership model in favour of shares-based public ownership like any other company listed on the stock market, belongs to a wider discussion of the merits and demerits of privatisation. Quite apart from the wisdom, in many cases, of privatising government-owned concerns, in my opinion demutualisation and privatisation are two different concepts that should have been kept separate but that appear to have been conflated to a significant extent.

8.2 The Social Construction of Economic Identity

It is useful to summarise briefly the basic fiscal policy mechanism used by a nation's central bank. In times of recession, when money is scarce, the central bank (CB, i.e. the Bank of England in the UK, the Federal Reserve in the USA, or the European Central Bank in the Euro zone) effects "quantitative easing" (QE) operations, for example buying government bonds (debt) on the bond market.[141] The CB stores the bond certificates in its vault and effects corresponding transfers of money into the bank accounts of the bond sellers. However, these are not proper "transfers", in the sense that normal citizens or consumers experience. In other words, when, say, £100m due to the sale of a certain number of bonds appear in the bank account of the bond trader, an equal amount does *not* disappear from the CB account, *because there was nothing there to begin with*. In other words, the £100m have been "created" out of thin air by the CB. Similarly, in times of over-inflation, the CB may decide to withdraw money from circulation. It does so by selling the bonds it holds on the bond market. When the bond traders send their cheques to the CB the money "disappears". It is clear that in its ability to control this mechanism the CB wields immense power, which is probably the main reason why the creation of money is a state monopoly. Or is it? Interestingly, on a much smaller scale the WIR Bank has exactly the same power:

> The unique ability of the WIR Bank to provide new payment media via the granting of credit and the simultaneous creation of WIR money has occasionally given rise to the criticism that the WIR Bank represents an incalculable disruptive factor for the Swiss National Bank's fiscal policy, since it is the only Swiss institution aside from the National Bank able to create money. (Studer, 1998: 44)

Although Studer goes on to explain why such concerns are unfounded, our interest here is not in the mechanics of fiscal policy. Rather, it is in the role that the creation of money plays at the heart of the interaction between the four economic domains of value, which might be argued as follows. Over time, the members of the WIR community have become increasingly aware that the WIR enables them to formalise the trust they hold for each other in a manner that is visible to society at large, quantifiable, and economically enabling. The ability to transform trust (credit) into a "tangible" currency that they control completely has deep implications on what we might call the "social construction of economic identity". Although it is the WIR Bank that extends credit, and therefore trust, to a petitioning member, the potential harm a rogue member could do to the economic circle as a whole implies that each member feels some level of accountability to the WIR economic community and, similarly, extends their own trust to that community. Taking on a measure of risk is a form of personal investment that the members are willing to make for the success of the WIR. With this personal investment and responsibility comes a feeling of "ownership". Since the combination of trust, responsibility, accountability, and solidarity is formalised in their financial system as "credit" and implemented as "WIR", it follows that the sense of ownership that comes with these principles is projected onto the currency. Since this process is repeated countless times both in the context of WIR Bank governance as well as routine market transactions, it becomes an experience shared by all the members, which is communicated through language, balance sheets, and other "cultural" signs. This is more

[141] See http://www.bankofengland.co.uk/monetarypolicy/assetpurchases.htm for more details.

or less the definition of "social construction", as explained in a footnote in Chapter 6. The localisation of the Euro coins into the different countries of the Euro zone is a clear example of the importance money has always had for reflecting and reinforcing national identity. The case of the WIR or, in fact, of any CC, is one of enablement and empowerement of a given community, which feels better able to take charge of its own *economic* destiny through the creation, ownership, and control of its own currency. Hence the concept of social construction of economic identity.

Figure 8.2 shows how an "eCC" modelled on the WIR can be seen as a "fountain-like" feedback or return from the market and capital domains back to the base and social relationships precisely through this community/economic identity construction process. The importance for the domain of capital comes from the large loans and mortgages that this kind of CC system also enables and mediates.

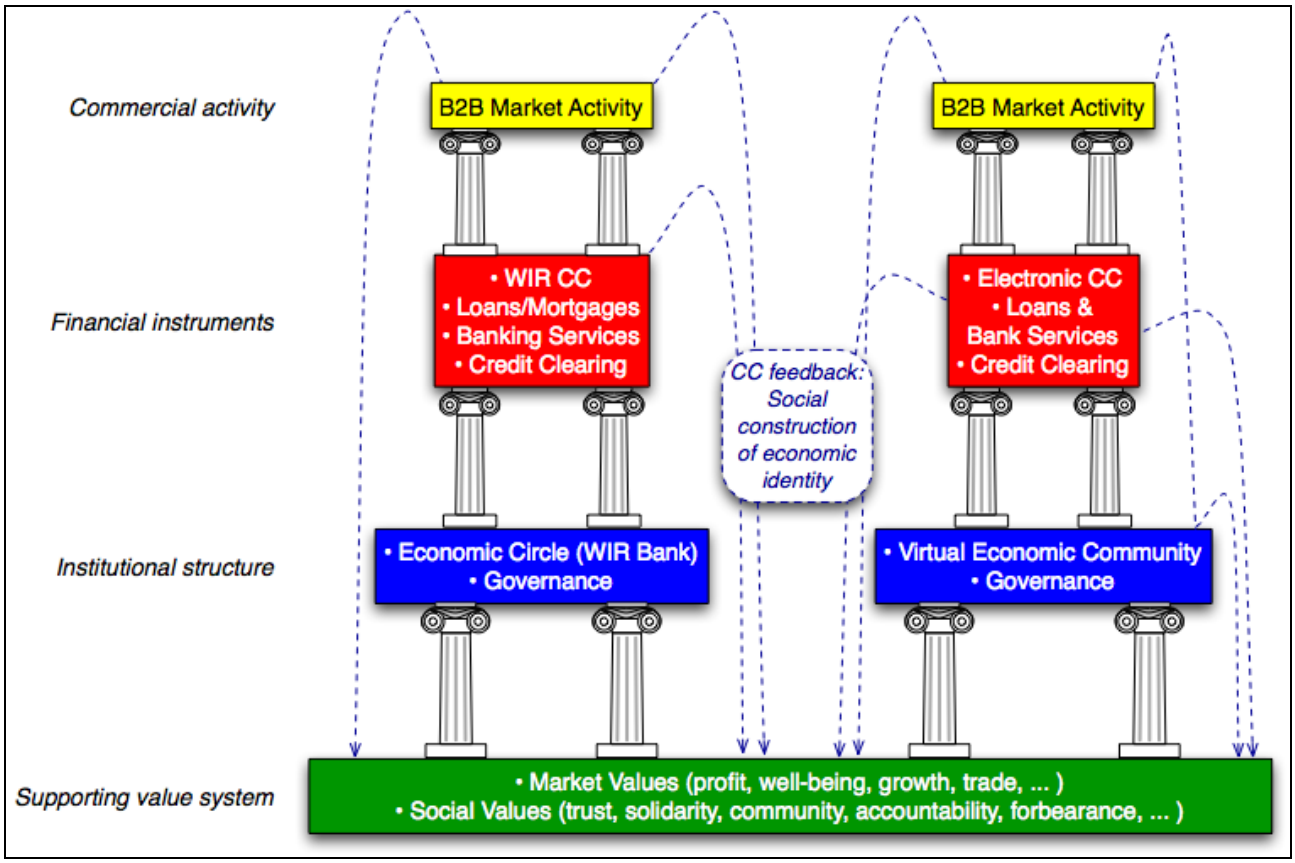


Figure 8.2: Feedback from the market and capital to the base due to the WIR and a WIR-like eCC

This discussion brings us to an interesting realisation. In the case of cooperative banks and building societies the intangible social values are "exchanged" mainly at the institutional level, within the domains of social relationships and the base. Thus, although they support the market and capital domains, they are not in turn supported by them beyond standard financial enablements. By contrast, in communities with a currency such as the WIR the CC is able to mediate the exchange of these values in addition to capital and commodities in trade. It is in this sense that a CC such as the WIR is able, to some extent, to connect Gudeman's otherwise incommensurate value domains.

8.3 Outdoor Museum for Smartphones in the Midlands

I discuss another example that uses a local and physical CC and that shows how the four domains of economy can be integrated in innovative ways and through reliance on broadband. I first describe the project and then map its constituent parts to the four value domains.

Q-Archive (Rathbone and Palmer, 2011)

The project Q-Archive aims to research, test, and demonstrate a new way to disseminate existing cultural repositories more widely by delivering such content, on-demand, at the point of interest, and in a user-friendly way via smart phones and QR codes. The project consists in establishing how to adapt the "front end" technology of QR codes and mobile devices, and how to organise and manage the "back end" of content authoring, preparation and management: both in the technical and in the social science aspects of networking volunteer communities. Q-Archive will show a low-cost way of opening up the vast treasure of knowledge and information locked away in various forms of public repositories, archives and collections by facilitating and coordinating existing experts and volunteers as content managers for mobile media. Our specific pilot project is based on the historical and archaeological archives of the County of Leicestershire and their existing pool of active experts and volunteers. Q-Archive is meant to become a commercial cloud-based service during the course of the project. The target market is any collection, museum, or cultural visitor attraction with information assets that could be presented via the user's own mobile media during their visit.

The broadcast media have demonstrated time and again through popular programme-making the widespread interest in historical, archaeological and genealogical studies, and the natural sciences if they are presented in the right way. An Ofcom report (2011b) shows that 30% of the adult population now have smart phones. Yet currently, the public may pass by historically important buildings, walk around an ancient monument, or picnic at a site of scientific interest, without any availability of cultural information that they may find fascinating or educational because of their location at that moment in time. QR Codes are a kind of "square bar code" used in Japan since 1994 for tracking manufactured goods. Their use is now rapidly growing in Western countries, as a method for consumers to respond electronically to advertisements in magazines or posters. Our users will use their smart phones or tablet PCs to read a printed "QR tag" at their location, which is the only location-based infrastructure required. The code will automatically take the user to location-specific content, for example a web-based guided tour with informative text, historical pictures, images of archaeological artifacts, or graphical reconstructions. With superfast broadband it would be possible to access also spoken commentary and video.

The user thus comes equipped with their own highly sophisticated delivery infrastructure. The cultural partner has only to assemble the content, and to convert content, such as the guided walks and illustrated talks, that are already undertaken for small groups by their experts and volunteers, into an appropriate format for mobile media. Much content is available digitally, or could be easily digitised using existing volunteers. The CMS used for this project will also contain tools for social networking and community building, acting as a facilitation mechanism for volunteer groups. The work of content origination and management can thus be distributed among a network of experts, staff, volunteers, and even visitors inputting their observations and knowledge (oral history). We will use a free open source community-maintained CMS which will facilitate the easy adoption of the system by similar organisations, either by copying Q-Archive or subscribing to it as a service. The production of the master images for the QR tags will be an integral and automatic part of the content generation process.

The project involves two sample installations: Visitors to Borough Hill, the site of an iron age hill fort, but a place where there is very little cultural information, will be able to have a guided walk, read about the site, see graphical reconstructions, look at photographs of recent archaeological digs and their finds, take part in a treasure hunt or similar challenges. Visitors to the historic centre of Melton Mowbray, who come generally for its famous pork pies and

markets, will be able to start a guided tour of the town centre from any one of several places. The tour will look at its architecture, social history, archaeology, and natural history, and take in the museum which has several local history themes.

Table 8.1 shows how the elements of the Q-Archive project fit quite naturally with Gudeman's domains of value. I include also possible mechanisms of economic exchange.

Table 8.1: Mapping the Q-Archive project to Gudeman's value domains

Value Domain	*Relevance to Q-Archive*	*Currency and/or Interaction Mechanisms*
Base	• Cultural repositories, historical & archaeological archives and collections • Open source CMS • (Superfast) Broadband IP infrastructure • Web stack of languages and standards (including the QR codes) • Social networking platform running next to CMS	• Public investment • Spoken word • Information and knowledge • Community currency
Social Relationships	• Network of Experts and Volunteers interacting with each other as they transform cultural content (Base) into digital information and knowledge assets (Accumulation) • Experts and Volunteers interacting with Visitors • Community of Experts and Volunteers providing feedback to Technology Partner • Network of Software Developers maintaining CMS	• Community currency to recognise time and effort
Accumulation/ Capital	• Cultural and social capital within the existing pool of Experts, Volunteers • Digital information and knowledge assets • Widespread ownership of sophisticated mobile information infrastructure (smartphones) • Oral history inputs from Visitors • Wider community creation across all stakeholders (Cultural Partner, Volunteers, Technology Partner, Visitors, Software Developers) • Higher quality of touristic experience for Visitors • Profit for the Technology Partner • Regional economic growth from tourism • Community currency system as a local institution	• Information assets • Knowledge assets • Cultural assets • GBP
Market	• Commercial cloud-based service offered by leading Technology Partner to Cultural Partner • Technology Partner developing and maintaining delivery channels	• GBP

Figure 8.3 attempts to show how the introduction of a CC of the kind of Ithaca HOURS or Brixton Pounds supported by a broadband infrastructure facilitates the operationalisation of the Q-Archive example in a manner that is consistent with Gudeman's domains of value. It is not clear whether *superfast* broadband makes a big difference in this example, but it is not hard to imagine analogous scenarios built around online gaming, for example, that would benefit from superfast broadband.

This example also serves to show how a CC system that has such strong local ties, although important for the local economy, is likely to remain a small-scale phenomenon. A WIR-like B2B system based on an eCC, by contrast, can grow more easily by supporting "Virtual Economic Communities" (VECs) that connect SMEs from outlying areas in the UK to the rest of the world.

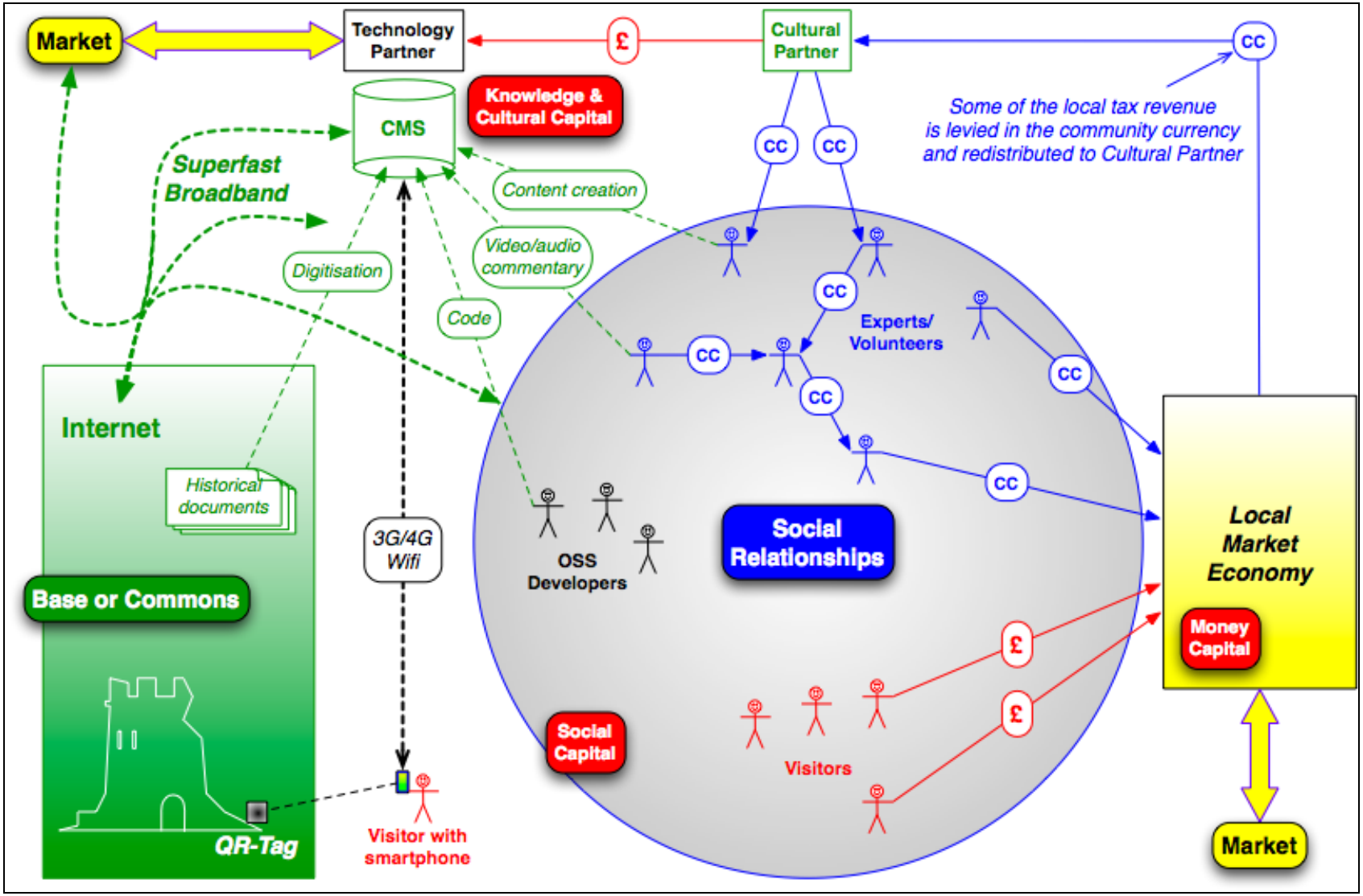


Figure 8.3: Possible integration of a community currency with the broadband-enabled value domains for the Q-Archive example (Dotted lines indicate data flows, solid lines indicate currency flows, block arrows indicate interactions)

8.4 Superfast Broadband, Community Currencies and Smart Solutions

An argument of this paper has been that whether or not superfast broadband is a worthwhile investment depends on the metric(s) with which the benefits are assessed and/or quantified. The "ploy" to extend the definition of economy is appealing, but it will not cut much ice if it is not supported by a mechanism to connect the value created in the different domains. Arguably value is *already* being created in the different domains but there is no clear and agreed system in place to make the different domains work together. In this chapter, I have therefore argued that other elements need to be brought in to connect the domains.

The example just discussed is consistent with an attempt to quantify social value. Whereas this appears to be possible if one relies on a currency that emphasises use value over commodification and exchange value, the limited scale of most CC systems makes it difficult to imagine how such an approach could lead to monetisation in the market domain. This perception is made even stronger in the digital economy by the growing and unstoppable tide towards free content. Whereas cooperative banks have for a long time provided a model for scaling up economic activity in adverse credit conditions by relying on social relationships and a well-recognised base, the WIR has gone a step further by making the *currency itself* a part of the base. In other words, the WIR exemplifies what we might call "Open Source Money". Therefore, it seems worthwhile to explore further whether the many and growing online phenomena built around social networks, open knowledge, and free content could amplify the reach and turnover of a currency that depends on a self-governing community for its existence but that, at the same time, can provide noticeable economic advantages to that community in the context of trade – advantages that otherwise can only be accrued through the economies of scale of more traditional institutional forms. The radical ultimate implication of this line of argument is the break-up of the state monopoly on the supply of money.

The proposal that follows, therefore, is based on a shift in perspective. Rather than focusing on online social networks and free content creation as the locus of socio-economic activity that needs to be commodified, the model proposed is based on bringing what is normally regarded as market-based activity into the sphere of the base and social relationships. The claim here is that this can only make business sense if a WIR-like system is adopted. Further, it leaves open the question of what *more* could be done if the social value and the products of peer production embodied in the free content flowing around the Web were to be connected more closely with the "financial base" so constructed. In essence, the overall argument is meant to amplify the "entrainment" of economic activity by social interactions more than current ways of doing things are able to do. That this happens is very clear and quantifiable through the dual payment of any one good or service in a CC and a national currency, in particular the fourth component mentioned by Studer in Section 6.7, even if WIR grew out of an initiative that was meant first and foremost to facilitate trade. I now look at the possibility of mapping a WIR-like approach to the digital economy, and at the role smart solutions could play in such a mapping.

The challenge is to connect users and companies in geographically remote areas to the economic activity "at the centre" by leveraging the Internet and, in particular, superfast broadband. The experience of WIR is to complement market interactions with an institutional context that involves shared ownership of the banking infrastructure, i.e. a base or commons, and an open governance framework that relies to a significant extent on social relationships. The proposal here is to set up a similar credit-clearing system aimed at B2B

interactions and based on a similar cooperative structure that, crucially, involves the infrastructure investors and/or operators only *indirectly*. Specifically, a possible approach could be for private investors such as Virgin Media or BT to create their own "WIR-like" systems, each with its own currency. The fact that Virgin Money has already been established is an interesting and ironic coincidence. Here, by contrast, I am arguing that it would be advisable for the parent companies to participate in such systems through spin-offs that could engage in cooperative-style ventures with other companies. This is what is meant by "indirectly". Each venture would be a different economic circle, i.e. there would be one for Virgin, one for BT, and so forth.[142]

The initial membership of these economic circles would be open to companies from the areas of the UK in which superfast broadband investments are being made, but it could expand to companies in other parts of the UK and the world. Prerequisites would be the passing of credit checks similar to those performed on WIR applicants, and an upper bound on size, thereby favouring SMEs. Each "ecosystem" of companies would gradually develop the characteristics of a community. There would be an incentive to trade with each other, as in the WIR, but no obligation. So, participation would mainly make it easier to obtain credit and, as in the WIR, possibly also a certain level of match-making between supply and demand. Trades would be performed in both the "local" currency and the national currency (£), as for the WIR. For trades between companies residing in countries with different national currencies, only the portion of the payment in national currency need incur exchange fees; the portion in the CC is immune to such costs, providing an additional incentive for joining and participating.

Member companies could switch circle but could not join more than one at a time, thereby providing a degree of competition between different communities and, indirectly, currencies (echoing some aspects of Hayek's proposal). The role of the infrastructure providers would be as equals as far as the governance framework of each circle is concerned, since they would be participating through their (SME) spin-offs, but they would be free to name the currency something that reflects their brand name. Each circle would have the structure of a joint-ownership cooperative, like the WIR. The goods being traded could be anything, but since all transactions would be mediated by the superfast broadband network knowledge-based and content-oriented businesses would probably be in a privileged position to innovate their business models by leveraging the social networking, free content, and bandwidth-dependent value-added components of their businesses.

The spin-offs would in essence end up playing the role of the WIR Bank, becoming something close to "non-profit" banks. Therefore, it would be advisable for the spin-offs to set up local branches in the various regions where the infrastructure investments are made in order to interact with local stakeholders through direct contact. It would be advisable to hire local people for such offices, thereby signalling that the investment is not just being made in the technology. The parent company would not, therefore, derive a profit directly from such a banking business. They would accrue profits indirectly, through the greater

[142] A possible drawback in participating in one of these economic communities from the point of view of competition is the risk of lock-in to a particular provider. This would require careful thought and probably some regulatory intervention, for instance to decouple the provision of communication and media services from the provision of credit services and the membership in a given economic community.

economic activity facilitated, fostered, and supported by their spin-offs and mediated by their networks. They would have a strong incentive to “play fair”, be “good citizens”, and make each economic circle a success in order to increase the social capital of their brand name.

In such a scenario, it is fairly evident that the billing and rating services and the match-making services between consumers and providers would need to be able not only to scale up with the volume and the growing number of different kinds of services, but also with several different currencies and parallel cash flows. Smart solutions would become not only useful and helpful, but essential for mediating what amounts to the interactions of the different domains of an enlarged, more inclusive, and more participatory multi-scale economy.

9. CONCLUSION

This paper has surveyed policies, strategies and tactics for deploying and encouraging the take-up of superfast broadband in the United Kingdom. It has considered the costs and benefits from different angles: technology, society, and a broad conception of the economy. Accordingly, we offer the following propositions for debate.

Broadband investment provides essential services for relatively modest outlays

Universal availability and widespread use of high-speed broadband services will be fundamental to the future international competitiveness and social cohesion of the UK. The costs of broadband infrastructure run into billions but are modest compared to the costs of energy and transport infrastructure, which together are forecast to absorb over £200 billion of investment. They are also modest compared with the benefits and savings that they facilitate. Yet the funding for broadband from all public sources (not just the government) is likely to be less than, for example, the government revenue from the forthcoming digital dividend spectrum auction (which should be between £1.1 billion and £2.5 billion).

Achieving the potential benefits offered by high-speed broadband involves behavioural change, which takes time. The UK projected deployment time scale and bandwidth per head are not very ambitious by the standards of some other advanced countries, but are consistent with reasonable expectations for take-up and use. Provision of fast and superfast broadband will build on achievements in providing and using basic broadband, in a virtuous circle of growing supply and demand.

A broader view, encompassing community value beyond the conventional market, further underlines the importance of investment in superfast broadband for all (over the next decade or so). This view should also make superfast broadband more attractive politically and socially, and consequently provide a more receptive and fertile investment environment.

Both public and private funding are needed to reach the fast and superfast broadband targets

The Government's Universal Service Commitment for basic broadband to reach the whole country by 2015 is on course. However, meeting the government targets of 100% fast broadband coverage and 90% superfast broadband coverage in 2015 will absorb not only the funding from public sources but also roughly equal funding from private sources. This calculation assumes that government funding is matched by funding from the local authorities and devolved administrations, to give a total of about £1.3 billion. It is an approximation: funding requirements, and the need for funding from private sources, could vary greatly, according to the characteristics of local areas, the costs of activities other than deployment, and take-up.

The European Digital Agenda targets of 100% coverage of broadband at 30 Mb/s and 50% take-up of broadband at 100 Mb/s by 2020 could be met provided that government funding continues beyond 2015 (and beyond 2017, which is as far out as current projections go). Several technical developments can help with meeting the targets, as far as they relate to broadband speed; the best developments to implement will be apparent by 2017. However, work to increase take-up will still be needed, unless applications requiring 100 Mb/s per household spread even more rapidly than social networking applications, for example, have done.

Thus the next five years are a crucial period for growing broadband take-up, usage and capability among the whole population. Though the drivers of usage are not yet clear, entertainment is likely to play an even bigger role in getting people online than it has done so far. Current industry annual revenues are around £12 billion for television and £3 billion for residential broadband internet. So savings combined with revenue increases, of the order of 1.5% of these revenues each year for five years, would cover the likely funding from private sources. Given the move from physical to virtual entertainment media, a large part of the required funds could be generated in these ways, particularly given the increasing sophistication of real-time revenue maximisation tools.

Smart solutions can make a useful contribution

Smart solutions are already important tools for service providers in maximising broadband revenues, as they permit charging that can be varied in real time based on actual customer behaviour and network conditions. During the crucial next five years, smart solutions can have useful new roles in attracting new users and stimulating new uses of the Internet. These include:

- Helping non-users to understand and realise the value to them of the Internet.
- Ensuring that services use broadband infrastructure efficiently.
- Fostering network expansion and use through voluntary facilities sharing.
- Helping people to manage multiple purses (or currencies) for online transactions.
- Entering new fields of application that require complex multi-party groups of transactions.
- Helping businesses to achieve scale in their volumes of online transactions.

It is not possible to quantify these effects, but they should jointly make a significant contribution.

The return from investment in outlying areas of the UK might be increased if service providers introduced participatory non-profit banking systems tailored to the digital economy and based on community currencies. In this scenario smart solutions would play an essential role.

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ABBREVIATIONS

ADSL	Asymmetric Digital Subscriber Line
BEREC	Body of European Regulators for Electronic Communications
BIS	department for Business, Innovation and Skills
BSG	Broadband Stakeholder Group
BT	British Telecommunications
CC	Community Currency
CCRC	Complementary Currencies Resource Center
CIC	Community Interest Company
CMA	Communications Management Association
CMS	Content Management System
DCLG	Department for Communities and Local Government
DCMS	Department for Culture, Media and Sport
DEFRA	Department for Environment, Food and Regional Affairs
DOCSIS	Data Over Cable Service Interface Specification
DRM	Digital Rights Management
DVD	Digital Video Disc
EC	European Commission
eCC	Electronic Community Currency
ERDF	European Regional Development Fund
EU	European Union
FDD	Frequency Division Duplex
FTTB	Fibre To The Building
FTTC	Fibre To The Cabinet
FTTH	Fibre To The Home
FTTP	Fibre To The Premises
GDP	Gross Domestic Product
GEA	Generic Ethernet Access
GPON	Gigabit Passive Optical Network
HFC	Hybrid Fibre Coax
HIE	Highland and Islands Enterprise
HSPA	High Speed Packet Access
ICT	Information and Communications Technology
IETF	Internet Engineering Task Force
IP	Internet Protocol
IPR	Intellectual Property Right
ISP	Internet Service Provider
IT	Information Technology
ITU	International Telecommunication Union
LETS	Local Exchange Trading System
LLU	Local Loop Unbundling
LTE	Long Term Evolution
MIMO	Multiple-Input Multiple-Output

MPEG	Moving Picture Experts Group
MPF	Metallic Path Facility
MVNO	Mobile Virtual Network Operator
OECD	Organisation for Economic Co-operation and Development
Ofcom	Office of communications
Ofgem	Office of gas and electricity markets
ONS	Office for National Statistics
PCC	Policy and Charging Control
PIA	Physical Infrastructure Access
PLC	Power Line Communication
PPP	Public-Private Partnership
PTP	Point-To-Point fibre
QR	Quick Response
RFID	Radio Frequency IDentification
SLU	Sub-Loop Unbundling
SME	Small or Medium-sized Enterprise
SMPF	Shared Metallic Path Facility
TDD	Time Division Duplex
TUC	Trades Union Congress
UK	United Kingdom
UNESCO	United Nations Educational, Social and Cultural Organisation
US	United States
USC	Universal Service Commitment
VDSL	Very high speed Digital Subscriber Line
VULA	Virtual Unbundled Local Access